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COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVII JANUARY, 1912 No. 1

PUTTING THE SIPHON THROUGH

Up at the Storm King Canon they're working us day and night;
We've got our standard to hold to, we've got contractors to fight;
We live in boots and a slicker, we sleep when we get the time,
And our faces and hands are plastered with stickiest hard-rock grime;
We're too dog-tired for drinking, too sleepy to touch a card;
Our talk is all of the siphon—of rock that is soft or hard.
The wise guys laughed at the project; they said it would "never do"!—
But up at the Storm King Canon we're putting the siphon through!

We sunk a shaft in the mountain, where only the goats had played—
Where you had to hang by an eyelash to handle a pick or spade.
A shaft went down by the river—and the water commenced to pour;
And we plotted a plan to plug it—for that's what our pay is for.
We diamond-drilled on the bias, we sunk a shaft in the silt,
And sometimes the cold would numb us and often the heat would wilt.
We sought bedrock for ages and finally got a clew—
And down at the 'leven hundred we're putting the siphon through!

A seam was struck in the heading, far under the river-bed;
The water filled up the working and all of the runners fled.
But the pumps were set to going—we made a bulkhead to block;
And now once more the drillheads are battering at the rock.
The "hard-rock" gang were peaches—they entered into the game,
They laughed at the thought of danger, they took each chance as it came;
And, though there were politicians who tried to hand us a few—
Up at the Storm King Canon we're putting the siphon through!

It's tough—but it sure is worth it; it's rough—but it's bully fun
To do the thing that the wise guys have prophesied can't be done;
And when the job is over and the water is rushing in,
Why—then is our chance to chuckle and then is our hunch to grin!
The stream will come from the mountains and into the thirsty town,
And we will have done our portion of bringing the water down;
So what if the work is wearing and things will go askew—
Up at the Storm King Canon we're putting the siphon through!

—Berton Braley in *Saturday Evening Post.*

PNEUMATIC AUTOMOBILE STARTERS

It is quite remarkable that the inconvenience, the labor and the danger of cranking the automobile for starting have been so long tolerated, and undoubtedly the greatest of recent improvements in gasoline cars has been in the quite general addition of some starting device. There are now in the market a half dozen of these devices, and it may well be believed that before long no machine will be built without one.

H. W. Perry, writing in *Motor,* says that the only type of starter which has passed the test of service in the hands of private users is the pneumatic, and it is not certain this originated in the United States or in Europe. The Saurer cars and trucks built in Switzerland and exhibited and sold in New York and Chicago in 1907, were provided with well designed air starters having all the essential features of the latest ones announced. Winton cars, which have for many years possessed an air control system as a distinctive feature, were fitted with automatic starters of the pressure type last year, and these have been continued and are one of the talking points of the Winton sixes for the coming year. Recently the Chalmers Moto Co. announced that its Chalmers-Detroit 36 horse-power medium-priced cars would be equipped regularly with compressed air starters. The Simplex Motor Car Co. and the Metzger Car Co. have also adopted starters of the same class for their 1912 Amplex and Everett models.

These several makes of starters are much alike in their main features although each is made exclusively for the cars on which it is used. In all of them the motor is utilized to produce pressure in a storage tank carried under the car. By pressing a push valve on the dash with the foot, the air or gas under pressure is released and passes through a distributor which is geared to the motor to act in synchronism with the pistons. The function of the distributor is to admit the air successively to the cylinders in which the pistons are on the working stroke. The pressure forces the pistons down, causing the other cylinders to draw in charges of fresh gas through the carbureter until ignition occurs and the motor runs on its own power.

In the Winton system, each of the middle pair of cylinders is fitted with a check valve communicating with the combustion chamber so that at each working stroke of these cylinders a small quantity of gas at high pressure passes through the valves into the storage tank. The Chalmers has a single check valve on the head of one cylinder. It is water-jacketed and serves to force air into the tank until a pressure of 150 pounds per square inch is attained, when the valve ceases to operate. Pumping valves actuated by pressure from the cylinders are also employed in the Amplex system, but they are positively controlled by a valve on the dash which is opened when pressure in the tank becomes low. The compressor used on the Everett cars is of the same general type but is not air cooled. In the several systems the pressure in the tank is indicated at all times by a gauge on the dash. All cylinders of the motor are connected with the distributor by copper or brass leads. Connection with the combustion chambers is by means of valves so that when the motor is running under its own power no gas will be forced back to the distributor.

The Chalmers and Everett distributors contain a metal disk revolving in a horizontal plane. A slot in the plate uncovers successively four holes (or six for the Everett six-cylinder model) through each of which air is admitted to one of the pipes leading to the cylinders. The distributor is so timed with the camshaft-gear that the slot in the disk passes over the holes in the order in which the cylinders fire, the air passing first to the cylinder that is on the working stroke.

The only time when this system will fail to start the motor is said to be when the motor stops on dead center, which cannot occur with a six-cylinder motor and but rarely with one in which the crankshaft is offset. It has the advantage, on the other hand, of getting the moving parts in motion before the first explosion occurs, as in hand cranking, thereby relieving the motor of whatever slight shock there may be incident to starting on the spark. Another decided advantage is that by connecting a rubber hose by valve to the tank, the pressure can be utilized for inflating tires, as in the Chalmers and Winton systems.

AN ABSOLUTE PRESSURE VACUUM GAGE

The vacuum gage here illustrated was described in a recent issue of *The Engineer*, London, the names of inventor or maker not appearing.

Engineers who have charge of large power stations in which steam turbines are used know how necessary it is that the vacuum gauges connected with the condensing plant should register correctly, for a variation of 1 in. in the vacuum has a substantial effect on the steam consumption of the turbines. The ordinary vacuum gauge has one great drawback for this class of work. It makes no allowance for the variations of the barometric pressure. Hence a vacuum gauge may indi-

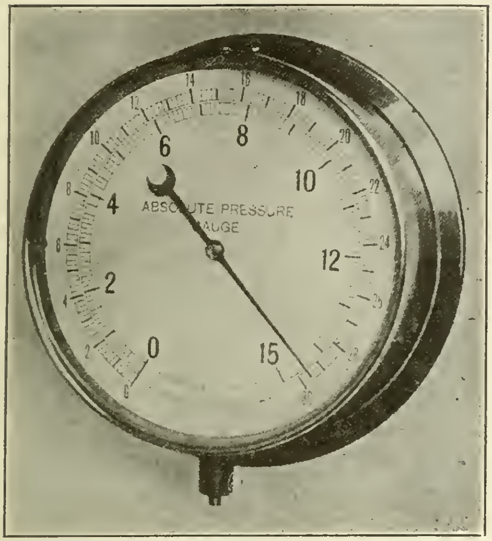

FIG. 1.

cate at one time 28-in. mercury and shortly afterwards only 27-in., and yet the absolute pressure may have remained unaltered, the change being simply due to a drop in the atmospheric pressure of 1-in. The engineer-in-charge has therefore, in such cases, to refer to his barometer and make a calculation.

The gauge, shown in Fig. 1, has been designed to obviate the use of a second instrument and the attendant trouble of calculating the absolute pressure data at each reading. It consists essentially of two sensitive Bourdon tubes coupled in such a manner as to oppose each other in their action. The inside of one of the tubes is in communication with the inside of the condenser, or other chamber from which the air has to be exhausted, whereas the outside is open to the atmosphere. This tube is therefore actuated by the difference between the atmospheric and absolute pressures in the condenser. The second tube is evacuated and hermetically sealed, and is therefore actuated only by the changes of atmospheric pressure; so that if the absolute pressure in the condenser increases from, say, 2-in. to 4-in., while the atmospheric pressure remains the same, the finger of the dial will be advanced accordingly and 4-in. absolute pressure will be indicated. If, on the other hand, the absolute pressure in the condenser increases from, say, 2-in. to 4-in., while the atmospheric pressure falls 1-in., the increase of pressure inside the tube would be 2-in. and the pressure outside the tube would decrease 1-in., and the resultant motion imparted to the pointer in an ordinary gauge would correspond to a change of 3-in. As, however, in the gauge we are describing the atmospheric pressure acts also on the outside of the evacuated tube, the fall in this pressure of 1-in. mercury will cause the tube to expand and thus oppose the action of the vacuum tube to the extent of 1-in., and the resultant motion transmitted to the pointer will be equal to 2-in., and an indication of 4-in. absolute pressure will be recorded on the gauge.

It will be observed from the accompanying sectional drawing, Fig. 2, that the two opposing tubes B, C are not coupled direct to the

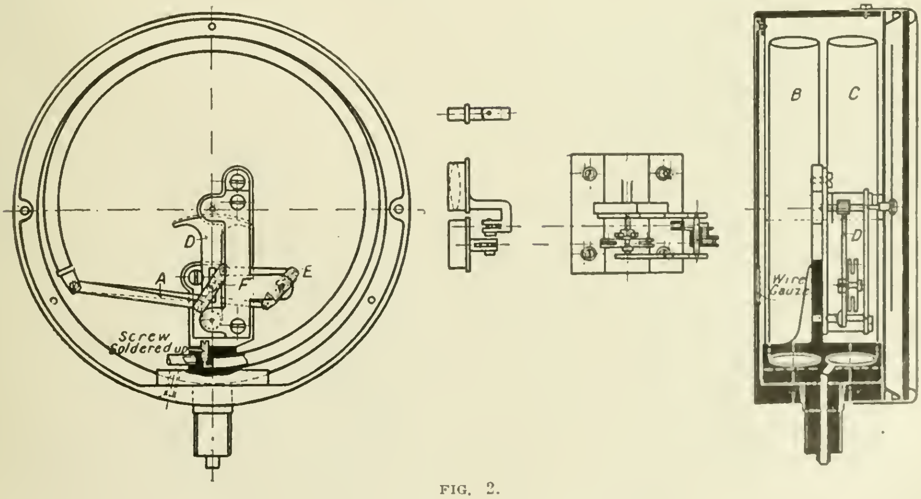

FIG. 2.

quadrant D of the gauge, but their action is transmitted by a special compensating link motion A, which removes the difficulty of the operating tube having to overcome the effect of the elasticity of the other tube, and avoids at the same time the friction which would be produced by the two tubes acting on one pinion in opposite directions. Both tubes are fitted and soldered into a common body and closed at their free ends by end pieces. The front tube C is in communication with the screwed shank at the bottom of the gauge, whilst the other is evacuated and hermetically sealed by means of a screw closing up the passage to the tube. Both the screw and the connection for evacuating the tube are further soldered up as an additional safeguard. To economise space the two tubes are arranged one behind the other, and in order to obtain the opposing effect desired for the barometric correction the movement of the barometric tube is reversed by means of a double lever E pivoted to an arm on the standard. The movement of the two tubes is, moreover, not transmitted direct to the quadrant of the gauge, but by means of a double lever F, or link turning about its centre on a pivot bolted to the quadrant, which latter is slotted to allow of adjustment of the leverage. Besides reducing friction this arrangement enables each tube to move with freedom without straining the other.

STEAM DRIVEN AIR COMPRESSOR ECONOMIES

By E. C. Sickles.

During the past it has been the practice to give but little attention to the cost of operation in the medium-sized compressed-air plants, and in some cases this holds true for the larger plants. First cost has been the main consideration.

Single-stage machines compressing to 90 or 100 pounds have been purchased with simple steam cylinders, operating at 125 pounds steam pressure at the throttle. These have operated for years in localities where the fuel cost is high, and where difficulties were encountered, due to dust and carbonizing effects, with consequent losses in economy and explosions due to extremely high temperature conditions and troubles in lubrication.

Improvements have taken place more readily in the air end by the adoption of the two-stage compressors, with consequent economy, due to intercooling, and ease of lubrication because of lower temperature. In the steam end, however, the most economical arrangement of cylinders and valves has not been followed generally, and there has been considerable loss in fuel economy and through investment for increased boiler plant.

Among steam-driven compressors which have been used to a large extent may be mentioned those employing the Meyer valve on the steam end. This type of valve is customarily used in conjunction with a throttling governor, controlled by air pressure. As the valves are hand set, under varying condition of load without constant attendance it becomes necessary to arrange the valves to cut off at a fixed point, necessarily so late as to practically eliminate all the economies which might be expected if the compressor were driven under fixed conditions and constant output. If the Meyer valves are set at an economical cutoff, and a heavy load comes upon the machine, it will stop, and the air supply may be cut off at considerable inconvenience. This type of valve, if the attendant is not on hand to start it, therefore, involves, under varying compressed-air demands, either a loss in economy or constant attendance. The well known throttling type of governor, which is the usual adjunct to this type of compressor, does not permit the highest steam economy.

It therefore becomes necessary, even where the fuel-supply cost per unit is low, if the most economical commercial results are to be obtained to consider carefully not only the design of the compressor in detail, but also the factors entering into the cost of the compressed air plant. In the cost of a new plant this would involve comparison of the cost of the necessary boiler capacity installed, the cost of the compressor foundations, building and all other factors involved in the complete installation. The annual charges, based upon the total cost of the compressor installed for the same capacity of output, added to the cost of fuel, operation and maintenance costs, will give the proper basis for comparison and decision in the purchase of the most economical air compressor.

Since an air compressor is to deliver a certain amount of free air, compressed to a certain pressure, it is desirable in securing bids that the steam consumption be obtained, based

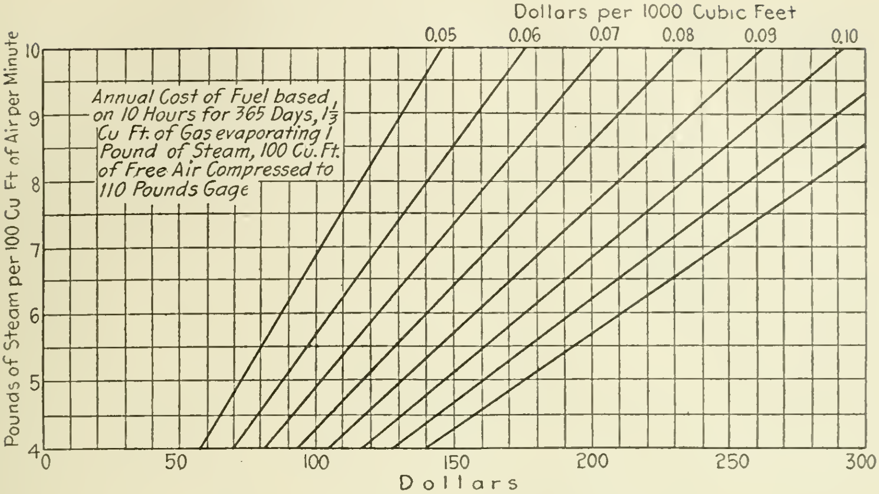

FIG. 1 COST OF FUEL WHEN USING GAS

upon 100 cubic feet of air compressed to the desired gage pressure.

On the accompanying charts are represented the annual fuel cost of compressed air, based on 10 hours for 365 days, when delivering 100 cubic feet of free air compressed to 110 pounds gage. Fig. 1 represents the cost when gas is used for fuel under the steam boilers, and Fig. 2 when using coal. The price of gas is taken as varying from 5 cents to 12 cents a thousand cubic feet, and the price of coal from 70 cents a ton to $1.50 per ton. As a sample of what may be expected from a compressor of approximately 1200 cubic feet capacity, of compound noncondensing steam end with an economical valve gear and two-stage air end, it might be stated that the steam consumption per 100 cubic feet, compressed to 110 pounds gage, is approximately 6.4 pounds of steam.—*Power.*

COMPRESSED AIR ON THE PANAMA CANAL

The principal air compressor plants on the Panama Canal are at Los Cascadas, Empire, Rio Grande and Balboa. These furnish air to the Central and Pacific divisions, and along the high line around Gold Hill on the relocation of the Panama Railroad. For the year ending June 30, 1911, the total output of these plants aggregated 8,261,199,541 cubic feet of free air, at a cost of 0.0324 cents per 1,000 cubic feet.

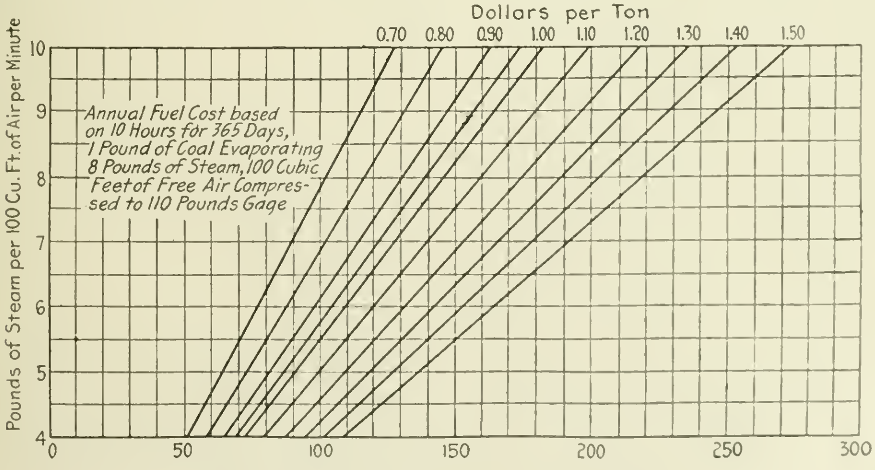

FIG. 2. COST OF FUEL WHEN USING COAL

DRAFT AND DIFFERENTIAL GAGES

By Julian C. Smallwood.*

A cubic inch of water at 60 degrees Fahrenheit weighs about 0.036 pound; hence, a column of water 1 inch high and 1 square inch in cross-section will exert a pressure by its weight of 0.036 pound distributed over the square inch of its bottom surface of contact. If the column is made 2 inches high, this pressure is doubled, and so on.

Mercury, at 60 degrees Fahrenheit, weighs nearly 13.6 times as much as water; therefore each inch of mercury exerts a pressure of

$13.6 \times 0.036 = 0.49$ *pound per square inch*

The simplest form of draft gage, the U-tube, is that shown in Fig. 1. This is a piece of glass tube bent in the form of a U and partly filled with water. It is connected to the flue at *A* by a rubber tube, and when the two water levels are the same the pressure in the flue is the same as that without. But if the level on the flue side of the U-tube is H inches higher than the other, then the pressure of the atmosphere on the open side of the tube is enough greater than the flue pressure to raise the weight of *H* inches of water against it. From this difference in level the difference in pressure is obtained between that in the flue and atmospheric pressure expressed in inches of water.

Such an instrument is easily made and can be put together at small cost. It is not always easy to bend the glass into the form of a U, in which case two straight pieces of glass may be joined by a piece of rubber tubing, as shown in Fig. 2. These may be mounted on a board to which a paper scale is glued and afterward varnished.

The simple U-tube is applicable also to pressures greater as well as less than atmospheric, the high level then being on the open side. For measuring pressures of more than one pound, however, the water gage becomes inconveniently long. Hence, for this purpose a heavier liquid, such as mercury, which will not rise so high, is used. Each inch of mercury being equivalent to 0.49 pound per square inch, indicates a pressure 13.6 times as great as that shown by water.

The scales of these gages are graduated in various ways. Some have an ordinary scale, as in Fig. 2, which requires the height of both levels to be read and then the lower subtracted from the upper to obtain the difference in level. Others are graduated as shown by Fig. 3, the purpose being to avoid two readings. A U-tube supplied with this scale must be filled until the level on both sides is at the zero graduation. Either the upper or the lower scale is read and the reading is doubled to obtain the inches of water. If any of the water is evaporated or otherwise accidentally lost, however, the reading will be inaccurate.

Another form of scale is shown by Fig. 4, which obviates doubling the reading. This may be made adjustable through a small range so that its zero may be readily brought to coincide with the no-pressure position of the water level.

A gage giving direct readings may be made as shown in Fig. 5. This consists of a cup *C* of comporatively large diameter, containing liquid in which a glass tube of small bore is placed. As the liquid rises in the tube the level in the cup sinks, but on account of the large area of the liquid in the cup its level does not sink appreciably. Thus, if the cup is 2 inches in diameter and the tube 1-8 inch bore, for each inch the level in the tube rises that in the cup falls 1-256 inch. If the gage range is 5 inches, the total fall of level in the cup is about 1-50 inch, which in this case is negligible. If the cup is a closed chamber except for a tube leading into its air space, the instrument may be used as a differential gage.

It is on the principle of this gage that the mercury barometer is made, the form of the instrument being like Fig. 5 except that the glass tube is closed at the top and air excluded, as in Fig. 6. This is an absolute-pressure gage as distinguished from a differential gage, the absolute pressure of the atmosphere being recorded by the hight of the mercury column, as there is no other force in the tube than that due to the weight of mercury. A thumbscrew *D* is arranged to adjust the level in the open vessel at a fixed hight shown by the point *E*.

The simple U-tube may be used to show the difference of pressure in two parts of a closed pipe by connecting its two sides, one to each part, as shown by Fig. 7, instead of leaving one side open to the atmosphere. When measuring forced draft it should be connected in this way, one side to the ashpit, the other

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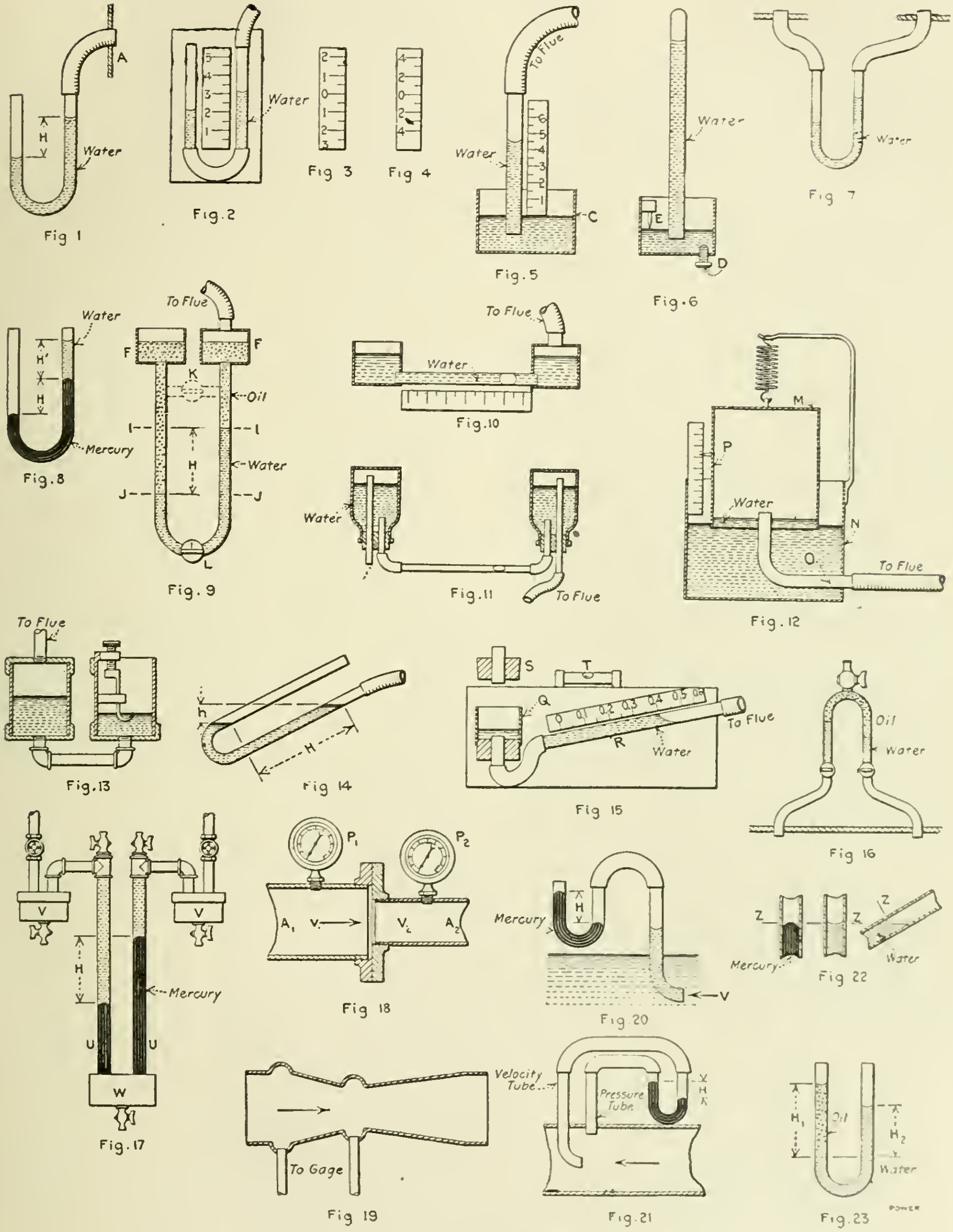

Fig 1 Fig. 2 Fig 3 Fig 4 Fig. 5 Fig. 6 Fig 7 Fig. 8 Fig. 9 Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig 14 Fig 15 Fig 16 Fig. 17 Fig 18 Fig 19 Fig 20 Fig. 21 Fig 22 Fig. 23

VARIOUS FORMS OF GAGES

to the chimney flue. The pressure in the ash-pit is greater than that of the atmosphere; that above the fuel bed may be less.

In some appliances for measuring the flow of steam the U-tube may be used, its form being somewhat different for practical purposes. When mercury is employed water of condensation settles on one side of the mercury column and influences the reading. This may be corrected as follows: Considering Fig. 8, the true difference of pressure is

$$H + \frac{H'}{13.6}$$

inches of mercury; that is, the water column in inches is divided by 13.6 to obtain the additional pressure in inches of mercury. If the water were on the other side it would be subtracted.

As applied to furnace drafts, the U-tube as described is not satisfactory because ordinarily, with natural draft, the difference does not exceed a few tenths of an inch. Therefore the instrument is difficult to read closely and does not indicate small changes of draft. To overcome this difficulty a great many ingenious devices have been constructed.

It would appear at first that the difficulty could be overcome by employing a liquor lighter than water. It is not practicable, however, to obtain one enough lighter to magnify the difference of level sufficiently, but two liquids, differing from each other in density, will answer the purpose. Thus in Fig. 9 assume the upper liquid to be oil whose specific gravity is 0.9 and the lower liquid water. If the levels in the cups *F F* are the same, then there is a difference of pressure corresponding to the difference in the weights of the column *H* of oil and water. Above *I I* the columns of oil, being of equal hight, balance each other, below *J J* the water columns also balance. Between *I I* and *J J* there is a column of water acting against the flue pressure and one of oil, equal in hight, acting with the flue pressure. As the pressure of the oil is 0.9 that of the same hight of water the draft is equal to $(H—0.9\ H)$ or $0.1\ H$ inch of water; that is, the draft in inches of water is one-tenth of the reading. In general, calling the specific gravity of the oil S and h the draft in inches of water,

$$h = (1 - S)\ H$$

If the heavier liquid is not water and has a specific gravity S_1, then

$$h = (S_1 - S)\ H$$

By choosing the liquids for such a gage of nearly the same densities, any desired range may be obtained for the measurement of a small difference of pressure. The more nearly equal in weight they are the greater the motion of the liquid for a given draft. In general, the number of inches of rise in the ordinary U-tube is multiplied by $\dfrac{1}{S_1 - S}$

In practice, when used as a draft gage, the difference of level in the cups *FF* would alter the foregoing relation. To keep the cup levels the same a cross-connection with a cock *K* *joins* the tops of the tubes. Another cock *L* is placed at the bottom of the tubes. When in use *K* is closed first and *L* opened; when the oil stops rising in the right-hand tube, *L* is shut and *K* opened and the flue connection is removed. This allows the oil in the cups to come to the same level again without disturbing the levels in the tubes. The cocks are then reversed until the oil has risen again as high as it will, and the level in the cups is adjusted once more. This is repeated until the oil no longer rises, upon which the reading is taken.

The draft gage shown in Fig. 10 consists of two cups, one closed, the other open to the atmosphere. They are connected below the water line by a horizontal tube of small bore containing water in which there is a small air bubble. The motion of this bubble is a measure of the draft. As the water rises in the right-hand cup the bubble moves to the right a distance proportional to the difference of level in the cups. By making the ratio of cross-sectional areas of the cup and the tube bore the required amount, any desired range of motion may be obtained, the motion being inversely proportional to the ratio of areas.

Fig. 11 shows how this form of gage may be easily made from two bottles with perforated corks together with glass and rubber tubing.

A draft gage designed by Professor Kent is shown by Fig. 12. It is made of two tin vessels *M* and *N*, the former inverted and suspended within the other by a spring. Its interior is subjected to flue pressure through the tube *O*. The pressure of the atmosphere being greater tends to push down the suspended can. This tendency is opposed by the spring and, according to its extension recorded by the pointer P, the draft is measured. The equation of the instrument, neglecting buoyancy, is

$$p \times a = 0.036\ h \times a = n \times H$$

from which,

$$h = \frac{n \times H}{0.036 \times a} = k \times H$$

where,

p = Difference between fuel and atmospheric pressures in pounds per square inch;
a = Internal cross-section, in square inches, of can M;
n = Number of pounds corresponding to 1 inch extension of spring;
H = Extension of spring in inches corresponding to $p \times a$ pounds;
h = Draft in inches of water;

$$k = \frac{n}{0.036a}$$

The equation ($h = k\,H$) shows that to obtain the draft the reading on the scale is multiplied by a constant which is less than one. The increasing buoyancy as M sinks is negligible if the design of the gage is good. This instrument does not quickly respond to changes of draft, however, and is cumbersome.

Fig. 13. Shows Miller's draft gage in which the difference of level is not magnified, but a very precise instrument, the hook gage attached to a micrometer, is used to measure the level.

Perhaps the simplest and most satisfatcory form of draft gage is the variation of the ordinary U-tube shown by Fig. 14. It is set on a slant so that a vertical difference of h inches between the water levels causes an actual motion of H inches. By varying the slant any desired magnification may be obtained. This is generally made with a scale on the principle illustrated in Fig. 4 so that only one reading need be taken. It may be readily constructed of a piece of gage glass Q (Fig. 15) and a glass tube R together with some rubber tubing; perforated corks S may be used if forced draft is to be measured. The gage should be mounted on a board to which a spirit level T is attached so that the slant of R may be kept as intended.

For the purpose of making this gage more compact the slanting tube is sometimes in the form of a helix.

Most of the previously described gages are applicable to the measurement of water as well as gas pressure, the liquid used in them for this purpose being mercury or oil. Fig. 16, for example, shows the ordinary U-tube inverted for use with oil.

Fig. 17 shows a gage using mercury for large differences of pressure. One-eighth-inch pipe and fittings are used and the long gage glasses U U are joined by a cast-iron well W. The pots V V are arranged to catch the mercury should the pressure become sufficiently great to blow it beyond the gage glasses. The cocks are arranged for introducing the mercury and excluding the air. In the right-hand column there is acting a weight of H inches of mercury which is partly balanced by the same height of water on the other side. The mercury column causes a pressure of 13.6 H inches of water; therefore the pressure difference indicated by the gage is

$$13.6\,H - H = 12.6\,H \textit{ inches of water}$$

or 1.05 H feet. That is, to interpret the reading of this gage its reading in inches must be multiplied by 1.05 to get the difference of pressure head in feet.

APPLICATIONS OF THE DIFFERENTIAL GAGE.

In Fig. 18 the symbols P, V and A stand for pressure head in feet, velocity and area in square feet respectively at the two sections of the pipe. Since the sections at A_1 and A_2 are different, the velocities will be different, V_2 being as many times V_1 as A_1 is times A_2. Neglecting the losses due to friction, etc., the total energy of the water in the one section is equal to that in the other, this energy being in two forms, pressure and velocity. Since the velocity in the small pipe is greater than that in the large, the pressure in the latter must be less and the diminution in pressure energy must equal the gain in kinetic energy. Therefore, the difference of pressure in the two pipes is a measure of the velocity and consequently the quantity, according to the following relation:

$$Q = \frac{A_1 \times A_2}{\sqrt{A^2_1 - A_2^2}} \sqrt{2\,g\,(P_1 - P_2)}$$

in which Q is the quantity flowing in cubic feet per second and g is the acceleration due to gravity, 32.16. This is the principle of the venturi meter, a very precise instrument for the measurement of the flow of water. It has also been applied to steam and perfect gases but with less success. Fig. 19 shows the usual proportions of the meter, the actual discharge being between 95 and 99 per cent. of that shown by the formula.

Fig. 20 reprsents a Pitot tube, another instrument for measuring velocities and quantities. It is a tube having a quarter bend, set facing the direction of flow. The hight H of the liquid in the tube is a measure of the velocity or

$$V = \sqrt{2 g h}$$

h being the head in feet of whatever liquid or gas is flowing. To convert the reading H to the equivalent head of the fluid whose velocity is being measured, it is necessary to multiply by the ratio of the densities of the gaging and the measured fluids. Thus, if the gaging liquid were 10 times as heavy as the fluid being measured, h would equal 10 H. In general,

$$V = \sqrt{2 g C H}$$

in which C is the ratio of densities.

The Pitot tube has been used largely for velocity measurements in open streams, but not until comparatively recent years has it been applied extensively to the flow of liquids and gases in closed pipes. Fig. 21 shows its arrangement for this purpose. Since in such a system pressure is recorded as well as velocity, a pressure tube is added. Static pressure only acts through this tube and balances the static pressure in the other tube; hence the gaging liquid records the velocity head only.

The simplicity of this device is alluring, but it should be used with caution in careful meassurements as a great many possible conditions may cause inaccuracies. The velocity of the fluid varies across the pipe section and the velocity tube must be placed at the point of mean velocity. The fluid sweeping past the pressure tube tends to make a suction reducing the effective pressure in it. If there are eddies in the current these also tend to distort the record. The gaging generally should be made in a clear, straight stretch of pipe where there is nothing to disturb the uniform passage of the fluid.

When used for the flow of water with mercury as the gaging fluid

$$V = 8.23 \sqrt{H}$$

and for the flow of air at atmospheric pressure and 60 degrees Fahrenheit, water being the gaging fluid,

$$V = 66.3 \sqrt{H}$$

in which V is the velocity in feet per second and H the reading in inches.

The gages described are useful in measuring losses of pressure in various parts of blower systems. By their use leaks may often be located and otherwise unsuspected losses remedied.

PRACTICAL HINTS.

The level of mercury in a glass tube curves from the center downward, while that of water curves upward. It is best to read the hight on a horizontal line tangent to the curve, as Z Z, Fig. 22. In the inclined-tube form of gage, if the tube is about ⅛ inch in diameter, the level takes a curve as shown, which is very conveniently read at Z. The bore of the tube used should not be too small as capillary action may cause error.

When oil is used as a gaging fluid its specific gravity may be found as shown by Fig. 23. A little oil is floated on water in one side of a U-tube and its hight H_1 and that of the column of water balancing it H_2 are measured. Then the specific gravity of the oil is $\frac{H_2}{H_1}$

Considering the units of pressure measurement dealt with, it is unfortunate and illogical that three different physical quantities and two starting points for measuring are employed when one would do. There is no reason why the ordinary spring-pressure gage should not be graduated in pounds above a perfect vacuum and its units used for whatever pressures are measured. U-tube scales, no matter what their liquid, could be graduated to read directly in pounds per square inch quite as conveniently as the present system of inches. It may be contended that for drafts and small pressure differences the pound is too large a unit. This could be remedied by using one one-hundredth of a pound as the unit for small pressures. There would then be 3.6 of these units to an inch of water. Condensed from *Power.*

The only gas produced from crude oil up to within a very recent period, has been one having a value from 550 to 680 B. t. u. per cubic foot, used for domestic lighting and cooking. This gas has been produced by the process known as the 'cracking' of the crude oils, which is largely disruptive in effect and frees a very large percentage of hydrogen and carbon, resulting in a gas carrying 50 per cent. and upward of free hydrogen. This gas will give no higher efficiency in a gas engine than distillate.

TESTS OF SAND BLASTING MACHINE

This paper gives the records, results and conclusions of a series of quantitative tests of a sand-blasting machine, under the actual conditions of commercial practice, which were made by David H. Ebinger and Robert A. Frevert, of Columbus, under the direction of the author as their thesis for the degree of mechanical engineer from The Ohio State University in 1910.

The conditions of this set of tests were as follows:

The material was pieces of cast-iron which had been broken as test bars for transverse tests. They were 2 in. by 4 in. in cross-section and from 15 to 25 in. long. They had been cast diagonally on edge in one mold from one ladle of machinery iron. Their rough surfaces were as uniform as were the bars themselves. A new nozzle, 5-16 in. in diameter, was used for each test. To remove any unevenness of the interior surface of the nozzle, and to bring them all exactly to the same condition, sand was blown through each for 2 minutes previous to starting the tests. The sand used was a No. 3-J Cape May grit, new, hard, sharp, clean, free from clay, and was such as is commonly used by the trade. It was thoroughly dried in a Pangborn No. 1, Type M, sand dryer. The sand was then passed through No. 8 mesh screen. After use in the machine, it was weighed, sifted, reweighed, and discarded. The compressed air was passed through a separator to relieve it of moisture from the atmosphere and oil from the compressor.

No attempt was made to regulate and adjust the proportion of air to sand. All tests were run with the regulating valve wide open. Upon the three remaining variables, the air pressure, the angle between the surface of the work and the nozzle, and its distance from the work, the quantitative experiments were made. The regular equipment of the D. A. Ebinger Sanitary Manufacturing Company at Columbus, Ohio, was used for these tests. It consisted of one sand blasting machine with a sand capacity of 4,000 lb. per charge. It was provided with a moisture separator, pneumatic sand separator, dust catcher and exhaust fan.

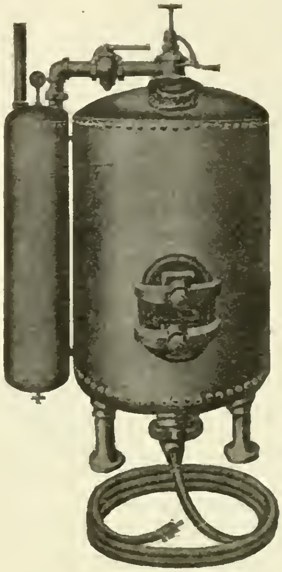

FIG. 1.

Fig. 1 shows the machine and Fig. 2 the regulating and controlling valves. Fig. 3 shows the mixing chamber for the air and sand. Fig. 4 shows a plan of the rooms and apparatus. Fig. 5 shows the sand-blasting box and sand-catcher. Fig 6 shows a photograph of the machine, blasting room and apparatus. Figs. 7 to 9 graphically show the results obtained.

OPERATION OF THE MACHINE.

The compressed air enters the moisture and oil separator at the left of the machine, passes through the air regulator *a*, which has an indicator-handle working over a graduated disc, enters and passes down through the cylinder *b*, inside the machine, then through the air ports in the piston *c*, and engages the entering sand. The ports in the top of the cylinder, one of which is shown, deliver the air to the sand chamber, so as to maintain equal pressure above the sand and to assist in insuring uniform flow. The sand-controller handle, *d*, moves on a quadrant, having limit stops for its off and on full positions. This handle permits the piston *c* to be rotated in its casing *e*, thereby opening, regulating and closing the sand ports by a single control. The stirrer and handle *f* connect with its fork which operates inside of the piston and mixing cham-

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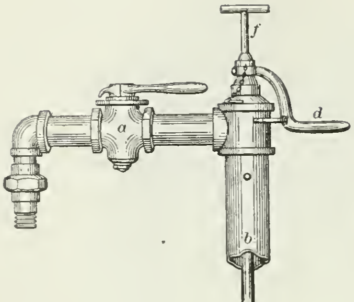
*Abstract of a paper presented at the New York meeting (Dec. 1911) of the American Society of Mechanical Engineers by Prof Wm. T. Magruder, Ohio State University, Columbus, Ohio.



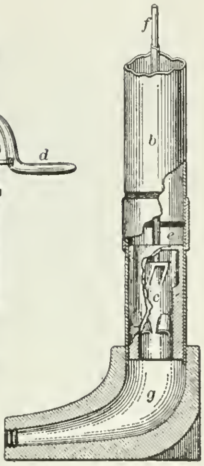


FIG. 2. FIG. 3.

ber for dislodging caked sand that may form under certain conditions. Ports, elliptical in shape, are located in opposite sides of both the piston *c* and the casing *e*, and are inclined downwards, so starting the flow of the sand by gravity. The rotation of the piston by the controller handle regulates the opening of the ports and the flow of sand. The sand on leaving the ports is met by the air coming through the ports in the piston. They cross each other from opposite sides into the mixing chamber *g*. By this cross flow, a swirling motion is produced and a thorough mixture of the sand and air is obtained in the rear part of the mixing chamber. The mixture is carried forward by the air pressure from the rear part, 2½ in. in diameter, to the hose connection where it is ¾ in. in diameter, thence through the hose to the nozzle, whence it is projected upon the casting to be sand-blasted.

The air used was measured by a pitometer placed horizontally in a run of straight 1½ in. standard welded pipe in the main air line, and located at a distance from any fitting. The opening, 1-8 in. in diameter, of the dynamic tube faced the current of air from the receiver tank. The end of the static tube was trimmed off flush with the interior of the pipe. The tubes were connected by 1-8-in. pipes to the ends of a water manometer. The difference in the levels of the liquid in the two legs of the manometer indicated the difference between the dynamic and static pressures, and is a measure of the velocity head in inches of water. From the formula, $v^2 = 2gh$, the velocity of the air in the pipe was calculated. Deducting the area of the dynamic tip from the area of the opening in the pipe, gave the net area of the air pipe. The coefficient of discharge was taken as 0.91. To remove the moisture that collected in the tubes, valves were placed in each of the tubes above the manometer, and pet cocks placed in the tubes directly above the valves. This arrangement permitted the blowing out of each tube before taking a reading of the pitotmeter. The temperature of the air in the line was taken just before it entered the stop valve at the machine. Calibrated pressure gages in the line and at the machine gave the desired pressures.

To collect the sand used during each test and also to control the blast, a closed box with a hopper bottom and a shelf at one end to support the test bar was prepared, as is shown in Fig. 5. The sand discharged during a test was collected in the hopper, removed, and weighed as total sand used. It was then sifted, and again weighed, thus giving by difference the amount of sand rendered useless

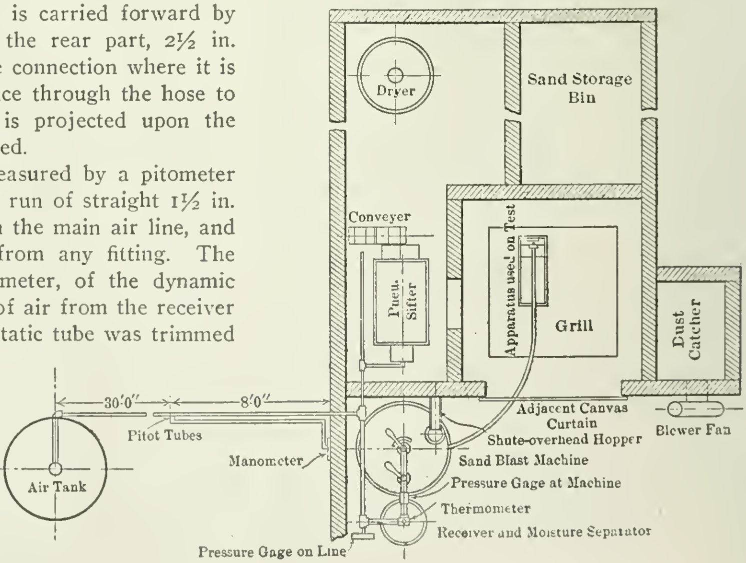


FIG. 4.

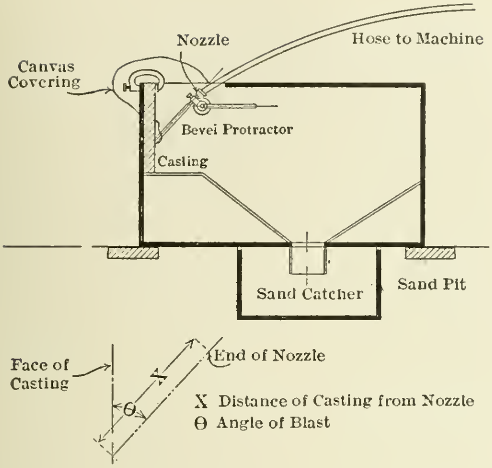


FIG. 5.

by the test, and the amount of sand that might be used again in commercial practice.

The test bar was held in a vertical position in the sand-blasting box. Before and after blasting it was weighed to quarter ounces.

In each test the new nozzle was first brought to a uniform condition by discharging a blast of sand and air through it for 2 minutes under a constant blast pressure. The test bar was weighed and placed in position in the closed hopper box. The nozzle was then set for its distance from the test bar and for its angle with the surface of the test bar. The air regulator *a* was kept wide open during the tests. The desired air pressure in the machine was secured and maintained constant by adjusting the stop valve in the supply pipe to the moisture separator. After starting the air blast and adjusting the valve to maintain a constant pressure at the machine, the sand-controller handle *d* was moved to its open position at the instant of starting, thus allowing sand to flow into the mixing chamber and to be forced by the blast of air out through the nozzle and against the test piece. Readings of the temperatures and pressures of the air on the main line and at the machine were taken at regular intervals of about 2 minutes. In closing down the machine at the end of a test, the sand valve was first closed and then the air valve; the test bar was weighed, and the difference of the two weights gave the amount of iron removed.

Starting at 20 lb. corrected pressure at the machine on the first test, and increasing by 10 lb. up to and including 70 lb. pressure, the to increase of pressure was obtained, with the nozzle set at 45 deg. and at 8 in. from the test bar.

In the second series of tests, a constant pressure of 60 lb. was maintained at the machine, and the nozzle set at 8 in. from the test bar. The angle was varied from 30 to 90 deg. The effectiveness of these angles of blast was in this way obtained.

In the third series of tests, the distance of the nozzle from the test piece was varied, the angle being set at 45 deg. and the air pressure maintained constant at 60 lb.

It was noted that with no sand flowing, the quantity of air flowing approximated the theoretical discharge for the nozzle. On turning on the sand, the quantity of air flowing immediately decreased; and when the sand was "on full," the amount of air discharged was only 40 to 50 per cent. of the original quantity.

With constant air pressure and with the sand-controller lever in its "on full" position, on account of the variation in the openings of the sand and air ports of the machine, about 30 tests were required to be made in order to get even fairly concordant results for the pounds of sand discharged per 100 cu. ft. of free air flowing per minute, as shown on Line 27, Fig. 7. For constant pressure, variations in the pitotmeter readings were due to the variations in the sand flowing. As the quantity of sand decreased, the velocity and quantity of air increased, but the quantity of sand discharged per pound of iron removed also decreased. It would seem that further experiments might prove that at other angles than 30 deg., and at other distances than 8 in., and at other pressures than 60 lb., less sand would be used per pound of iron removed if the sand-variation in the effectiveness of the blast due

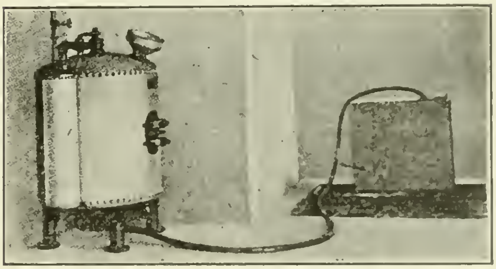


FIG. 6.

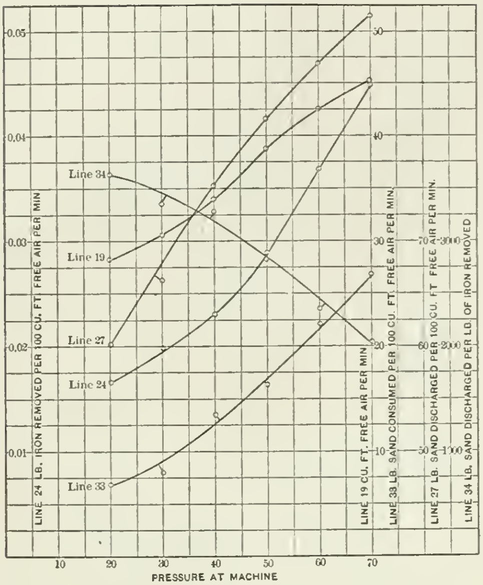


FIG. 7.

regulating valve was not open so much. This would make the energy of the individual grain of sand greater and its blasting effect larger. Furthermore, there would be less piling up of the sand on the surface being sandblasted.

From these quantitative experiments on a cast-iron test bar for these three variables, within the limits used, the results as graphically shown in Figs. 7, 8 and 9, are as follows:

For a constant distance of 8 in., and at a constant angle of 45 deg., between the nozzle and the test bar, the equivalent amount of free aid delivered per minute, the iron removed, the sand discharged, and the sand used up per 100 cu. ft. of free air flowing per minute, vary directly with the pressure; the per cent. of usable sand remaining, and the amount of sand discharged per lb. of iron removed vary inversely with the air pressure in the machine. (See Lines 19, 24, 27, 33, 30, and 34, Fig. 7).

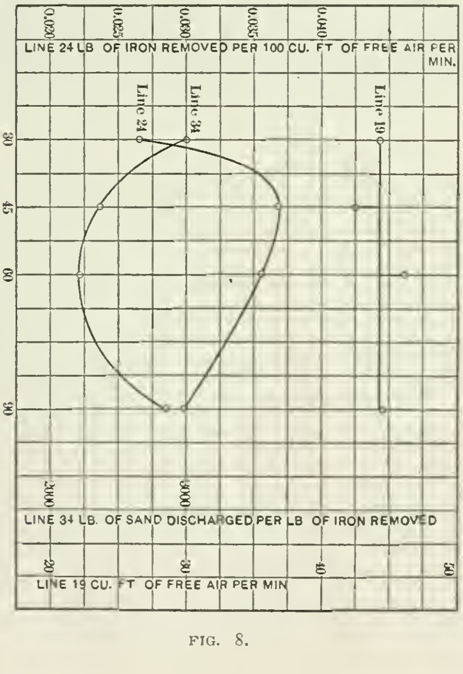


FIG. 8.

With a constant pressure of 60 lb. in the machine, and a fixed distance of 8 in. from the nozzle to the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the angle between the nozzle and the surface of the work was from 40 to 60 deg. (See Lines 24 and 34, Fig. 8).

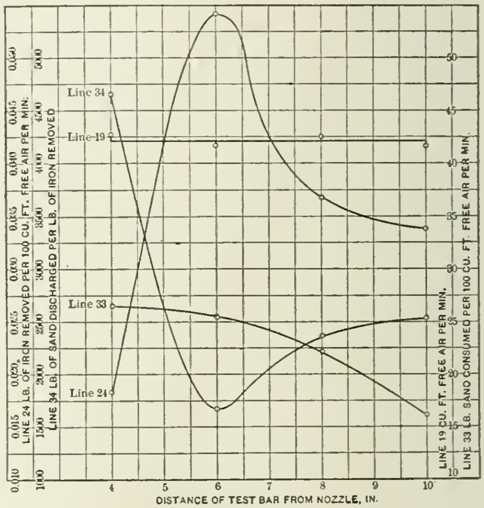


FIG. 9.

With a constant pressure of 60 lb. in the machine and a constant angle of 45 deg. between the nozzle and the surface of the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the distance from the nozzle to the work was about 6 in. (See Lines 24 and 34, Fig. 9).

With a constant pressure of 60 lb. and a fixed distance of 8 in. from the nozzle to the test bar, the amount of sand used up varies as the directness of the blast.

With a constant pressure of 60 lb., and a constant angle of 45 deg. between the nozzle and the test bar, the amount of sand used up varies inversely with the distance of the nozzle from the test bar. (See Line 33, Fig. 9).

For a constant angle of 45 deg., and a fixed distance of 8 in. between the nozzle and the test bar, twice as much metal was removed at 56 lb. pressure as at 20 lb.; at 64 lb. as at 30 lb.; and at 72 lb. pressure as at 40 lb. (See Line 24, Fig. 7).

With a constant pressure of 60 lb., and a constant distance of 8 in. between the nozzle and the test bar, over 20 per cent. more metal was removed with the nozzle held at 45 deg. than at 90 deg. to the test bar.

With a constant pressure of 60 lb., and a constant angle of 45 deg. between the nozzle and the test bar, 60 per cent. more metal was removed when the nozzle was held at 6 in. than at 10 in. from the test bar.

Unless it can be shown that the extra cost of compressing 100 cu. ft. of free air per hour to a pressure of 70 or 80 lb. per sq. in. exceeds the cost to compress it to 30 or 40 lb. by the cost of an hour of labor (25 cents), the higher pressures, delivered at an angle of about 45 deg., and at a distance of about 6 in. from the work, are to be preferred for the sand-blasting of cast iron.

RECORD RAINFALL

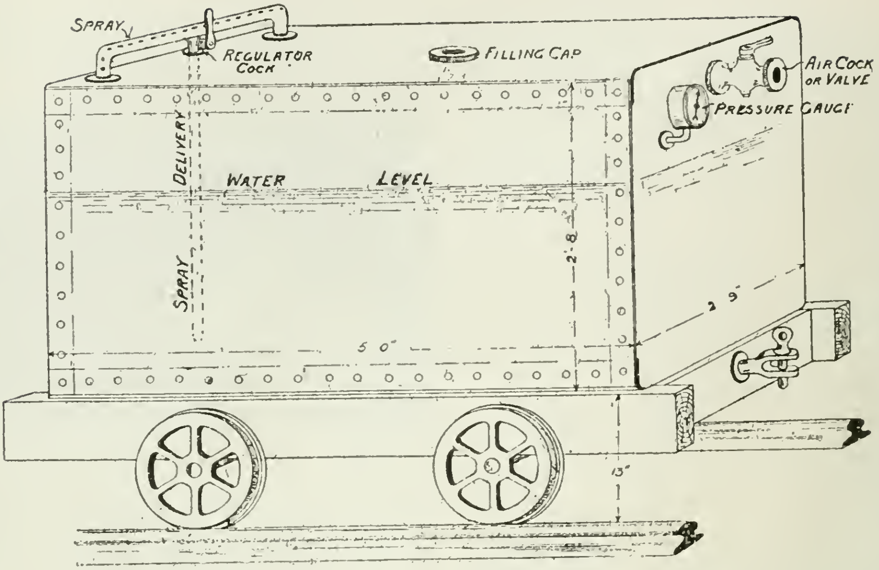
Lord Macauley has said somewhere that one who has never lived in the tropics knows nothing about rainfall. The greatest concentrated rainfall on record is reported at Manila, P. I., as having occurred in Western Luzon last July and August. There were three typhoons in that district between July 11 and Aug. 2, 1911, the heaviest of which raged from July 11 to 17. During the first three days of that period the total rainfall recorded at Baguio was 88 ins., 32 ins. of which is reported to have fallen during the first 24 hrs. Baguio is the mountain resort in the province of Benguet, at an elevation of several thousand feet. The road leading to it, which was built a few years ago at large expense and difficulty, is said to have suffered great injury from the floods following the storm. Two years ago there was a rainfall in Jamaica, W. I., of 48 ins. in four days, which was then thought to be the heaviest rainfall ever recorded for a limited period.

AN AIR LIFT REVIVES A RIVER

The half tone shows an air lift discharge from a large well turned into a river bed to maintain the flow. It is at San Antonio, Texas, where the river of the same name is in dry seasons little more than a series of stagnant pools extending through the city. More than 1,000,000 gallons per day were pumped during the summer from a 12 inch well in Brackenridge Park and turned into the stream as shown, greatly improving the sanitary conditions.

AIR HOSE FOR SOUNDING AND AS A SHALLOW WATER INDICATOR.

A shallow water alarm for ships has been recently tested out by freight steamers on the Great Lakes. It is not used in deep water, but is serviceable where the depths are not known and danger may be suspected. It consists primarily of a line of ½-inch armored rubber hose 300 feet long trailing under the vessel and through which air is kept flowing or ready to flow from an air receiver which is kept supplied by an air compressor. When a vessel so equipped is moving through the water at 14 miles an hour the inclination of the hose caused by the speed leaves the end of it 60 ft. below the surface of the water, and at this depth the air pressure is not quite sufficient to drive out the water and cause the air to escape. When, however, the end of the hose trails on the bottom at a depth of less than 60 feet the air begins to escape, a gage on the pipe showing the pressure at which the air escapes, from which the depth may readily be computed.

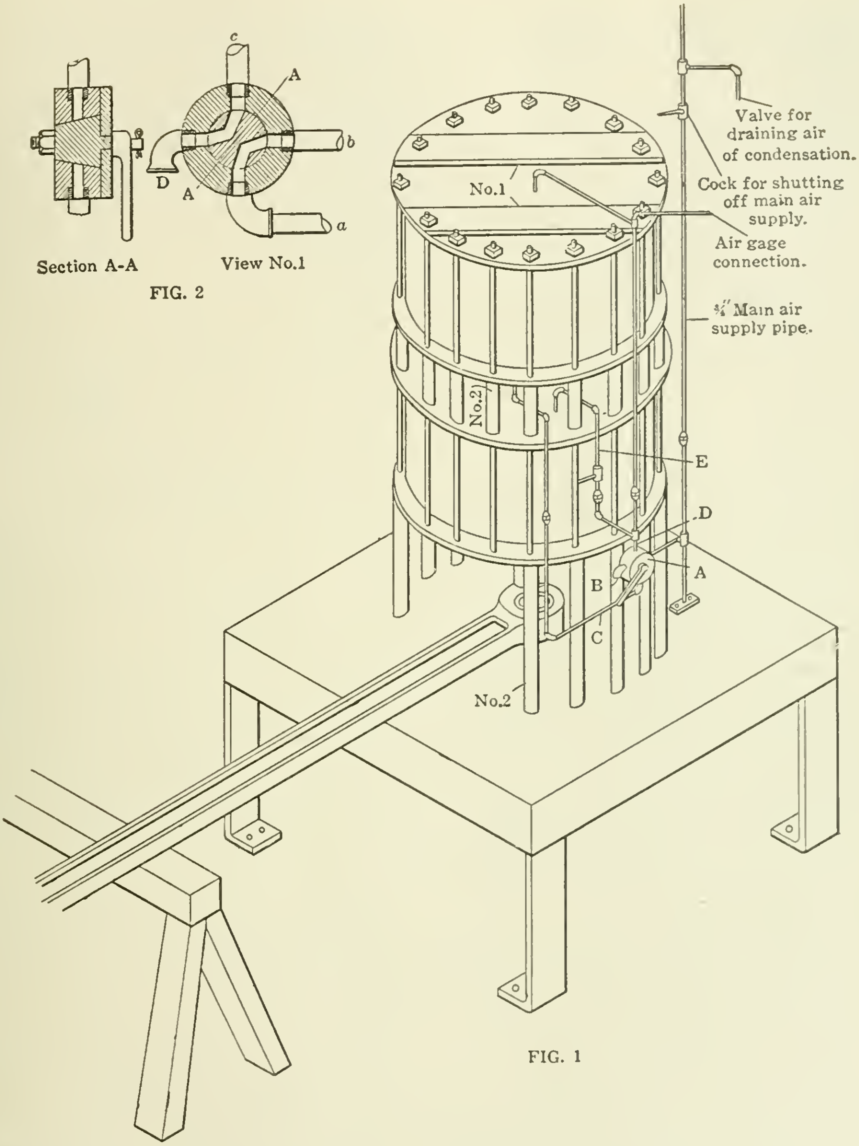


AN AUTOMATIC SPRAYING TUB

The cut, from Iron and Coal Trades Review, is an English contribution to the solution of the problem of spraying the roadways in coal mines. The "tub" is a rectangular tank of 3-8 in. steel plates riveted with 2½ by 2½ by 3-8 in. angles. The underframes are of oak, the centre bar, chain, and axles being of mild steel. The wheels are of cast steel, 14 in. in diameter. A vertical pipe extends from near the bottom of the tank up through the top at or about the position shown. A horizontal pipe, with downward curved ends, is fitted to the top of the vertical pipe, and extends the full breadth of the tank, a stop cock or valve being provided on the vertical pipe just below the junction. On the upper surface of the horizontal pipe there is a series of holes of such a size that water under pressure discharges through them, forming a thin sheet or curtain. The tank is charged about two-thirds full with water, and the space above the water is filled with compressed air, conveyed through the air cock shown from a compressed air supply, or if the supply is not available, the tank can be charged by means of a suitable pump. A connection is provided on the tank for coupling a hose pipe, provided with a spray nozzle on the end, to enable parts of the mine to be reached to which the tub cannot penetrate. A safety valve and pressure gauge are also provided. The spray extends to and strikes against the sides and the roof of the roadways. The dust is thereby deposited in a wet state on the bottom of the roadways, and can be removed in the ordinary way. In a recent trial, it is stated, the tub disposed of 150 gallons of water in a period of 45 to 50 minutes. With an initial pressure of 80 lbs. per square inch, reducing down to 5 lbs., it maintained a spray of 20 ft. all around. No mention is made of stay-bolts, but the rectangular shape would seem to demand them.

WILD FLOWERS AND UMDERLYING MINERALS

That certain flowers often indicate the existence of underlying zinc ores is well known to many prospectors. Also in our phosphate desposits in the west, the exceptionally luxuriant verdure usually permits the facile tracing of the phosphate bed where the latter is covered with soil. In Europe, a little violet, which is known to botanists as *Viola calaminaria,* grows in particular abundance in soils containing calamine zinc ores, hence the specific name of the flower. The same violet occurs at the Horn silver mine in Utah, which has zinc blende. In Sardinia there is also a special flower which seems to be restricted in habitat to zinc-bearing soils, and especially to those containing calamine ores; this flower is the *Anagallis collinae,* the bright orange-red buds of which bloom in May.



Section A-A View No.1

FIG. 2

Valve for draining air of condensation.
Cock for shutting off main air supply.
Air gage connection.
¾" Main air supply pipe.
No.1
No.2
E
D
A
B
C
No.2

FIG. 1

TANDEM AIRCYLINDERS DOUBLE THE POWER OF A PRESS

A very useful contrivance for the application and removal of rod bushings is shown in the accompanying drawing. It was evolved and is in use at the Winona, Minn., shop of the Chicago and North Western Railway, and is said to be a great time-saver over the method formerly in vogue of doing this work on a wheel press, an improvement in fact amounting to the handling of ten bushings to one.

It will be observed that the press consists of two tandem cylinders. These are 21-in. diameter by 12 in. stroke, and were made from a locomotive cylinder bushing. The heads are of ½-in. boiler steel, reinforced by two 1-in. x 3½-in. pieces of flat iron. The pistons are of ½-in. boiler steel, with a collar riveted in the center which acts as a reinforcement for the piston rod, and 1½-in. angles riveted radially for additional strength. The entire contrivance is held together with sixteen one-inch bolts, as shown in Fig. 1, part of them running through the work table, and the others only to the bottom head. Pieces of pipe (No. 2) around these bolts act as separators for the cylinders and between the lower cylinder and the table.

The apparatus is controlled by the three-way valve shown at (A), Fig. 1, and in section in Fig. 2. This is made of round stick brass with a taper plug similar to a cutout cock. Holes are drilled in the body and the plug as shown. (a) connects with the top cylinder and under the piston for raising both pistons: (b) with the main supply pipe, and (c) with both cylinders on top of their pistons for pressing in the bushings. When the valve is in the position shown in Fig. 2, the main supply is connected with pipe (c), Fig. 1, and the pistons are raised, while pipe (D) is connected with the exhaust (d), Fig. 2. By placing the handle in mid position the valve is closed; in the extreme position the main supply is connected with pipe (D), Fig. 1, and pipe (c) is in connection with the exhaust.

As an index of the pressure employed a common air gauge, registering to 100 lbs., was made use of by pasting a circle of paper on the dial with the approximate tons marked opposite each ten-pound division, this ratio being easily computed as follows: the area of the two pistons = 692.72 sq. in., divided by 2,000 = .346 tons for one pound pressure, and multiplied by 10, 20, etc., gives the equivalent entirely around the dial.

This press is placed near the end of the rod department in the Winona shop and is served by a one-rail traveling air hoist.—*American Engineer and Railroad Journal.*

THE TYPHOID MYSTERY

A physician I knew well, once had a case of typhoid fever at a farm house, and found that none of the people living in the house had been away for some time previous, and that contagion in this way was therefore impossible. He was absolutely unable to say how typhoid had got into the family. He examined the well, and so far as he could tell, it seemed all right. He happened to hear that nine miles away, there had been a great epidemic of typhoid. In that country, water does not always find its way to the surface of the ground very quickly, and it occurred to him that possibly there might be some connection between his patient's well and that nine miles away. So he got a large package of eosin [reddish coloring matter derived from coal-tar] and poured it into the well nine miles distant. Only two days later the water in the well which his patient used was red. A direct connection in this subterranean passage, by carrying the typhoid germs from that distance, had affected the family nine miles away.—*Dr. Harvey W. Wiley.*

ETHEREAL ASPHYXIA

Ethereal asphyxia, induced by abnormal atmospheric conditions, is what Calbraith P. Rodgers, transcontinental aviator, declares attacked him when he fell near Compton, Cal., on the last flight of his cross-country trip. Furthermore, Rodgers asserts, this is what caused the deaths of dozens of aviators.

"It lurks in the pockets of the upper air strata," he said, "and creeps irresistibly upon the senses of the aviator, lulling him into dreamy unconsciousness.

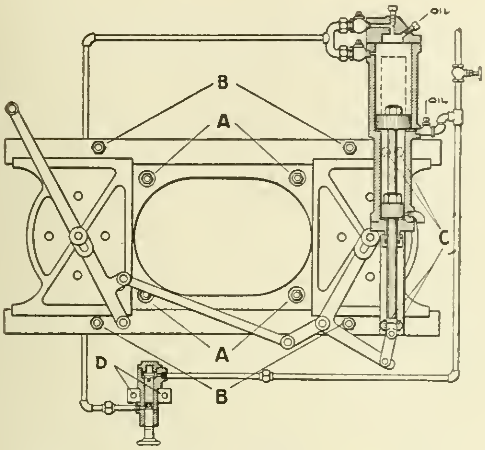
"I believe this same thing to have caused the deaths of Arch Hoxsey, Ralph Johnstone, Eugene Ely and a number of others who have fallen to their deaths from great altitudes, after having lost control of their craft.

"It was not in my case the rarified air that overcame me. I have experienced oxygen-lacking air a dozen times and it never affected me.

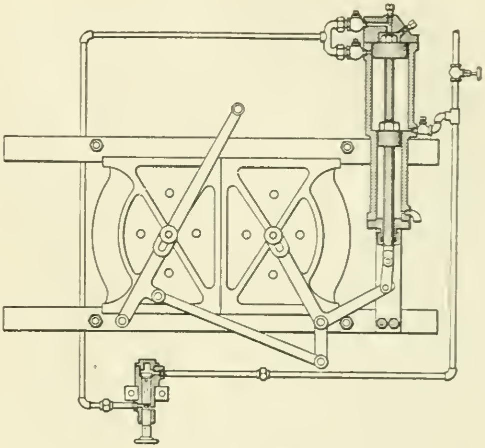
"There was no stifling sensation, but I did notice a peculiar odor, not unlike chloroform. I knew I was falling, but did not lose consciousness until within a few feet of the ground.

"The sense of drowsiness was first apparent shortly after I had passed over a small town south of Pasadena. I was up about 1,500 feet. I tried to shake it off, but it increased. The desire to sleep was irresistible. Then, I thought the machine could take care of itself. There was no pain, no noise in my ears. It was just a sweet, soothing feeling that I wanted to go to sleep.

"Somehow, I got a grip on myself and started on a long glide toward the earth. The nearer the ground I got the sleepier I became. I remember that I had righted my machine and was looking for a place to land when I suddenly lost all consciousness. It was then that I fell."



DOORS OPEN.



DOORS OPEN.

AN AUTOMATIC FIRE DOOR FOR LOCOMOTIVES

The cuts, from Railway Age Gazette, show the latest arrangement of the Shoemaker automatic air operated fire door for locomotives, made by the National Railway Device Company, Chicago. It is claimed that the parts which have heretofore rendered the door inoperative on account of intense heat have been eliminated, and that the air containing parts are sufficiently removed from the door opening to avoid trouble due to the extreme heat. In the Shoemaker air cylinder, the differential idea which has been so successfully embodied in the construction of the locomotive air pump, has been used, and with it the up-stroke of the piston or the door-closing movement is automatic. The doors are locked shut by air in their closed position, which prevents them from working open when the locomotive passes over sharp curves. The piston down-stroke or door-opening movement is secured by applying the air to the upper side of the large piston head by means of a foot valve. In both up and down strokes, the piston action is automatically cushioned, relieving the jar on the doors, lever pins, levers and the cylinder itself.

The two illustrations show the fire door open and closed. The door ring is attached to the locomotive boiler by the studs *A*. The door guides are bolted to the door-ring by stud-bolts *B*, and an upright plate, to which the air cylinder is fastened, is attached to the right hand ends by bolts *C*. The foot-valve, which is operated by a pedal, is fastened to the end of boiler by the stud-bolts *D*, which are the only additional holes necessary to be made in boiler other than required for the swing door. It will be seen from the illustrations that the fire door is composed of two distinct and self-contained mechanisms, each possible to operate entirely independent of the other. These may be properly designated as door parts and air parts. The operation of the former, when disconnected from the latter by the removal of a pin joining the fulcrum lever arm to the piston, is by a hand operating lever.

THE FOUNDRY CUPOLA BLAST

One of the disadvantages of operating two or more cupolas from a single blower is the variable resistance in the cupolas throughout the heat. Under such conditions, which are inevitable, especially if the cupolas are of different size, a constant pressure from the blower means that most of the air will go through that cupola which presents the least resistance, and this condition will obtain until the resistances are equalized. It is becoming recognized that volume is of greater importance for the successful operation of cupolas than pressure, provided, of course, that the pressure is sufficient to drive the air against the resistance. For use in foundries, where power economy is important, the Venturi tube may be used to maintain a constant volume by keeping the drop in pressure at a constant value. When economy is not important a gate or apertured disc will do. Such a volume control on the cupolas will automatically deliver to each the predetermined volume of air. —*The Foundry*.

THE HUMIDITY PROBLEM

Ordinary atmospheric air always has mixed with it some water vapor, which may vary from a very little in cool, dry weather to a much greater quantity in warm and damp weather. For sanitary reasons, as in heating and ventilating and for many industrial purposes, the measurement of this vapor content and its artificial regulation are matters of importance to engineers.

In general, the quantitative composition of a mixture of gases can be found only by chemical analysis. But when one component is a slightly superheated vapor, easily lowered to its temperature of saturation or of incipient liquefaction, a simple physical determination of its amount is possible. At saturation, charasteristic pressure and specific volume are both fixed by temperature alone. Further, a given space will contain the same weight of vapor whether this exists by itself, with its own pressure only, or whether it is diffused through a larger mass of gas, under the higher combined pressure due to vapor plus gas. If the "air" in a unit of volume is partly vapor of water, there will be fewer oxygen and nitrogen molecules than if no steam molecules were present.

Air carries its maximum content of vapor when the latter is in the state of saturated steam, ready to begin to condense on the least abstraction of heat; and the air itself is then said to be saturated with vapor. If less vapor is present, it may be considered as having been superheated from some lower temperature of saturation, under the pressure belonging to that temperature. Since vapor tension or saturation pressure rises with temperature, so does also the weight of vapor which a given weight of pure air can carry.

On these principles of thermal physics are based two methods of vapor determination. By slowly cooling a polished-metal surface and observing the temperature at which it just begins to be clouded with condensed vapor, the dew point or temperature of saturation for the actual atmosphere is found. The weight of a cubic foot of saturated steam at this temperature measures absolute vapor content or humidity, to be compared with the possible content at the higher prevalent temperature in order to get relative humidity.

Again, when water and nonsaturated air are in contact, vapor tends to be formed until the air becomes saturated. Vaporization absorbs heat, which may come from several sources, as from the air or water or from the surrounding bodies. If an original air and vapor mixture is the only source of heat, evaporation of enough vapor to saturate it will produce a definite degree of cooling. Practically, a current of air is blown over the wetted surface of a sheathing of cotton wicking wrapped around the bulb of a thermometer. After a short time for the establishment of stable conditions, this wet bulb will be lowered to a temperature such that the latent heat of the vapor formed will equal the sensible heat lost by as much of the air current as would be saturated by this vapor, at the temperature of formation of the latter, or of the water. Since the sample of air takes up vapor in addition to its original content, wet-bulb temperature is higher than dew point.

The wet-bulb apparatus is called a psychrometer. In a paper by W. H. Carrier, on "A Rational Psychrometric Formula," presented at the recent annual meeting of the American Society of Mechanical Engineers, the thermal relations involved in the action just described are clearly developed, and by means of charts are put into shape for convenient use. To the ideal operation of saturating air by vapor formed wholly at the expense of its own sensible heat, Mr. Carrier gives the convenient and accurately descriptive title of "adiabatic saturation."

The effects of humidity and the problems of air conditioning may now be briefly suggested.

The dew-point idea, in excess, is illustrated by the sweating of cold-water pipes, etc., in summer, and by the condensation on the windows of warm and moist rooms in winter.

The wet-bulb idea is best exemplified in the drying kiln, as for drying lumber. Heat to vaporize the moisture in the wood comes almost wholly from the hot air blown into the kiln, so that this air is subjected very nearly to adiabatic saturation.

In the cooling tower, on the other hand, evaporation is induced by air currents, but latent heat is supplied by the descending stream of warm water, intended to be cooled by the action. Consequently, the saturation capacity is that of air at but little less than the initial temperature of the warm water.

In heating and ventilation, the problem is to add vapor to winter air, which is made excessively dry and thirsty by raising it to indoor temperature; of course, the formation and heating of this vapor is an added burden on the heat supply. If air is cooled for summer ventilation, some of the vapor already present must be removed, most readily by supercooling, condensation and separation, to be followed by a partial reheating of the air.

When humid air is compressed, and after the heat of compression has been dissipated, most of the original vapor content is precipitated; as the total pressure is greater, the vapor tension (although absolutely the same for a given temperature) becomes relatively less, with a resulting decrease in the weight of air that can be carried by a unit of dry air. Unless the air is cooled near the compressor and the water is precipitated, there will be an accumulation in the pipes, with possible freeze-ups in winter, and perhaps trouble with the tools and the machines using the air.

In the operation of the blast furnace, dry air is most desirable, since water vapor is dissociated in the very hot zone just within the tuyeres, absorbing heat which is there much needed for the metallurgical reactions; hence the recent, most advanced scheme of refrigerating and thus drying the blast between blowing engines and blast ovens.

In all the examples so far cited, the vapor tension and the quantity are relatively small, but at the low pressures in steam-engine condensers, vapor volume is of the same order of magnitude as air volume, in a saturated mixture. For better effect in maintaining vacuum, modern condensers are so arranged as to produce localized and progressive cooling toward the outlet to the air pump, thus diminishing the proportion of vapor and the total volume of the mixture going to the air pump.—*Power.*

UNEXPLAINED AIR BLASTS IN MINING REGION

The recurrence of severe "air blasts" in the copper country of Michigan revives the question as to their cause. It has been stated, and is generally believed, locally, that the "air blasts" are due to the sudden displacement of large volumes of air, caused by the falling of great areas of the unsupported hanging walls in the old workings of some of the deep mines, notably the Quincy. A great deal of evidence tends to support this, but a brief review of the phenomena, with the attending results, leaves room for doubt as to whether or not the dropping of this rock is the initial cause.

The first serious shock is believed to have occurred during the summer of 1904. Data available indicates that it was at this time that serious caving was recorded in the old Atlantic mine, situated about two miles south of Portage lake. This first shock attained the proportions of a local earthquake and it was stated at the time that the tremors were felt as far as Marquette, about 90 miles distant, and at the Soo, several hundred miles from Houghton. It is certain that the blast was severe in the immediate vicinity of Portage lake, and was felt distinctly on the shores of Lake Superior, 10 miles north at what is known locally as the canal. Windows, china, pictures and chimneys throughout the district were broken, and all the effects of a light earthquake were noted. Lighter blasts occurred from time to time. During this period, caving continued at the Atlantic mine and finally in 1906 necessitated the abandoning of the property.

About this time serious caving began at the Quincy mine. Up to the present, this has accompanied each "air blast" and several times has caused temporary shutdown of one or more of the Quincy shafts, contiguous to the affected territory. The disturbances occurring in the last few weeks are apparently as severe, as regards surface evidence, as those of 1904 and 1906, and some of the reports regarding them are of particular interest. Several minor shocks preceded the main one, which is said to have centered in the vicinity of No. 7 shaft at the Quincy mine. Buildings on both sides of the lake were shaken, pictures knocked from the walls and crockery broken. Several chimneys were also dislodged. A boat unloading coal at one of the docks was noticeably swayed.

Some of the attending circumstances of many previous shocks are interesting. It has been noticed that before any tremors are observed, there occurs a dull but distinct thud, similar to that caused by a heavy object falling on soft earth. An instantaneous pause follows, after which come the vibrations. With the exception of the severe shock during the summer of 1904, it is safe to say that the great majority of the others have followed sudden changes, of some sort, in the weather and have happened in the autumn or spring months. The relation is doubtful but interesting.

A somewhat discredited explanation attributes the "air blasts" to a slipping of certain rock strata. This would place the disturbances in the earthquake class and in this connection it is interesting to note the remarks of a local pioneer. He states that the region was subject to tremors and quakes before any mines were opened. It is said that the "Indians knew of the country as 'rolling island' and entertained a wholesome fear of the district, believing it was the habitat of evil spirits." To date there does not appear to be a satisfactory or convincing explanation. Correspondence *Engineering and Mining Journal.*

AN AIR PRESSURE WATER TANK EXPLODES

Many small towns in Central Iowa and elsewhere use the air pressure water system, a sufficient volume of air being pumped simultaneously with the pumping of the water to maintain the required pressure in the tanks, thus dispensing with elevated reservoirs. This system has been in use for several years at Jessup, Iowa, and has proved highly efficient not only supplying all the inhabitants, but having already saved the town from several destructive fires. Recently, however, the tank, horizontal, 8 ft. diameter and 3 ft. long, exploded, destroying the building and wrecking pump and engine. The engineer had left the building, so that no one was injured. The writer, who sent an account of the catastrophe to the press, wrote: "It appears as though a safety valve should have been provided on the tank." We are not prepared to believe that a thing so necessary was not provided. We are constantly being reminded, however, that all automatic devices are not always and forever to be relied on if never inspected and cared for.

OZONIZED AIR FOR LONDON SUBWAYS

Much complaint is made of the condition of air in the London "Tube." It is announced by the Central London Railway Company that a system of ventilation will be installed capable of pumping daily 80,000,000 cubic feet of ozonized air into the stations and tunnels. In fact one plant is already in operation and it is hoped that similar ones will soon be completed at every station along the line. It is stated by one of the officials that the plant at each station will pump 400,000 cubic feet of air per hour into the station, or at the rate of 900 cubic feet per person per hour. The ordinary allowance in buildings is about 300 cubic feet of fresh air per person. The air is drawn from outside through a filter screen, which removes dust and dirt and impure gases. A part of the air is then ozonized by being passed over highly electrified plates. The air is driven by fans to the level of the bottom of the station, and two-thirds of it is distributed over the platform by ducts, with outlets at a height of 7 feet above the platform. The remainder is driven into the tunnel.

LAUNDERED AIR

[This poem was inspired by a description of a ventilating system, which states: "All windows in the office are kept closed and a constant circulation of fresh air is induced by means of rotary fans, and all air is washed and heated or cooled to proper temperature before being driven into the distributing ducts." It appeared in "Ryerson's Monthly."]

I can stand for tainted money, I can stand for tainted grub;
I can drink polluted water and employ it when I scrub,
But since noting this invention I shall never, I declare,
Be content again with breathing anything but laundered air.

Give me clothing filled with shoddy, filled with microbes, if you will;
Let a million microbes bite me when I touch a dollar bill;
Let the germs come swarming o'er me when I take an easy chair,
But I pray you do not give me anything but laundered air.

If ozone may be laundered, can't we neatly crease it, too—
Hand it round in snowy bundles like the laundry people do?
Oh, I hope the time is coming when to laundries we'll repair.
Bright and early Monday mornings for our week's supply of air.

National Laundry Journal.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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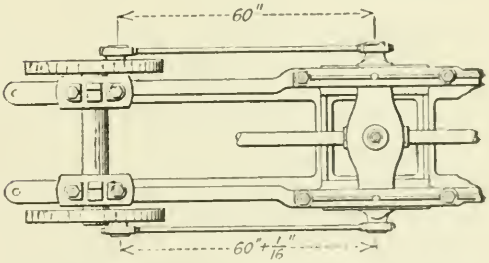
KNOCKING IN AIR COMPRESSORS

The following letter from a contributor, which we reprint verbatim, recently appeared without comment in *Power*:

"A double connecting-rod air compressor will frequently knock badly unless the air valves are in good condition and the steam valves are properly set. The knock is caused by the elastic spring of the air in the air cylinder acting against the steam piston when the steam is expanding, due to the cutoff. This trouble can be eliminated in part by setting the steam valves so as to allow plenty of steam to follow up the piston and not cut off too early. Straight-line compressors should have the valves set on the steam end so that the air valve will be closed on the compressor end when the steam piston is nearing the end of its travel; otherwise the elastic body of air will cause a bad hammer. Some knocks are caused by a wearing of the side-rod brasses. I have found them on double-rod machines so worn that one rod would be 1-16 inch longer than the other. Sometimes the crank pins are not equally distant, as shown in the illustration. New babbitt in the crankshaft bearings or thin copper liners between the end of the connecting-rod brasses on the short-rod end would remedy the defect."

Baltimore, Md.

C. R. McGahey.



The sketch shows a "straight-line" compressor of the familiar type. The steam cylinder, not shown, is between the crosshead and the crank shaft, and the air cylinder is outside, or to the right of the sketch, although the relative location of those cylinders might be quite different without changing the running conditions. The knock referred to certainly is *not* "caused by the elastic spring of the air in the air cylinder acting against the steam piston when the steam is expanded, due to the cutoff," whatever all that may mean. The cutoff is adjusted to suit the steam and air pressures and could not affect the knock, one way or the other. It is well known that in straight line compressors, with the air and the steam cylinders usually of the same diameter, the steam power at the beginning of the stroke is considerably in excess of the air resistance, and the surplus of power goes to accelerate the fly wheels, their momentum thus acquired serving to help out the latter part of the stroke when the steam power runs down to almost nothing and the air resistance is at the maximum. The knock is caused by the reversal of the connecting rod function in mid-stroke. If the thrust of the crosshead is downward at the beginning of the stroke it will be upward at the end of the stroke, and *vice versa,* and the only thing to do about it is to keep main bearings and connections set up as snugly as possible, and especially to have no vertical play between the crosshead and the slides over or under.

A slight difference in the lengths of the two rods is not a serious matter, as the crosshead is swiveled to compensate for that. If the writer had taken off both of the rods and accidentally or otherwise, had shoved one end of the crosshead forward or backward he might easily have found a difference of an inch or two between the two sides instead of the one-sixteenth reported.

FLYWHEEL ROTATION AND CROSSHEAD PRESSURE

"In air compressors where the air cylinders are directly behind the steam cylinders, running the compressor under brings the pressure of the crosshead on the lower guide; running it over brings the pressure on the upper guide, the tendency being to lift the machine from the foundation."—*Exchange.*

When the crosshead pressure is against the upper guide the tendency to lift the machine from its foundations is the same as that which a man experiences when he lifts himself by pulling on his boot straps.

In a straight-line, steam driven compressor, the crosshead pressure will be downward for a portion of the stroke and it will be upward for the other portion, no matter in which direction the shaft turns, for in the first half, more or less, of the stroke the steam will be doing the compressing and at the same time will be increasing the momentum of the flywheel, while in the other half of the stroke the conditions will be reversed and the flywheel will be helping the steam.

OZONE AS A PURIFYING AGENT

Although ozone is obtaining extensive recognition and industrial employment, current definitions of it are far from satisfactory. It is known that ozone is a colorless gas with a peculiar odor, and that is about all. It may be considered as a condensed oxygen and is one of the most powerful of sterilizing agents. It is produced in the atmosphere by lightning discharges, a process of oxidation and water evaporation and is not found to any extent in the air of the streets of our cities and consequently is a negligible quantity in the ordinary dwelling rooms of our great centers of population. But on the contrary it is found in the forests, sea-shores and mountains, especially during the spring and in agitated damp air, during gales and snowstorms.

Ozone oxidizes metals, whitens colored objects, destroys all kinds of organic matter found in dust, and other impurities of the air, as well as the microorganisms contained in water. On account of the decomposition which accompanies this oxidation, the ozone gives out one-third of its oxygen rendering most valuable help to modern sanitation, and ozonating plants have been installed successfully in Europe and America.

Whenever there exists a surplus of ozone, the absolute absence of oxidizable matter, or impurity in the air, is guaranteed. It is a fact that oxygen is the only product of reaction, and is the gas of greatest importance in giving the ozone undeniable superiority as a sterilizer. It was not until very recently that the construction of proper ozonators made it possible to use ozone effectively in sanitation. The devices constructed by Siemen and Halske transform the atmospheric oxygen into ozone by means of electrical discharges at high tension.

The city of St. Petersburg has just made an important application of this agent for the purification of water of one city, by installing a complete plant for ozonating water. The water in St. Petersburg was supplied by three great plants, of which only one (the greater one) had sand filters, while the other two were supplying water, such as it was, direct from the Neva. The new plant for the supply-of ozonated water was built on the premises of one of the two latter plants (that of Penkovaya) and it is capable of supplying 50,000 cubic meters (14,000,000 gals.) per day.

Before applying the ozone, the water is subjected to a preliminary purification by passing through rapid filters into reservoirs where by means of sulphate of alumina the matter contained in the water is precipitated. After this process of clarification the water is subjected to ozonation.

There are eight reservoirs for clarification connected with each other by means of conduits and equipped with 38 rapid filters. These are made according to Howamtson system which is almost similar to the American method of Jewell. The principal difference between the two is that Howamtson uses flint especially prepared for filling the filters in place of ordinary fine sand.

The filters are cleaned by washing them with filtered water and at the same time the flints are altered by means of special removers. The filtered water goes directly to the sterilizing towers, except a small volume diverted for cleaning the filters.

The. ozonating plant proper is composed of two parts: the ozonator battery, and the sterilizing towers. The ozonator battery comprises 126 elements and there are five sterilizing towers, one of the latter being held in reserve. The tubular elements of the ozonator batteries are based as stated above upon the action of high tension discharges between two cylindrical ends of aluminum and glass respectively. It is operated with a relatively elevated concentration of ozone (2.5 per cubic meter of air).

Before going through the ozonators the air is dried by refrigerating process in order to give the best results. Then it is blown through the ozonators by means of special conduits that absorb the ozonated air at an area of pressure of four meters of water, in order to mix it and pump it into the sterilizing towers. The absorption of ozone and the sterilizing of filtered water takes place partially in the conduits and partially in the sterilizing towers through which the ozonated air passes from the base to the upper part very finely pulverized, which prepares it for effective diffusion throughout the body of the water. After being aerated the ozonated water is deposited in special large reservoirs from which it is pumped at a high pressure for city distribution.

The plant is operated by an electrical plant equipped with boilers, steam engines, alternators, as well as three sets of high frequency converters through which the three phase current from the main generators are transformed into alternating current of 500 cycles per minute. The ozonators require for their operation a high frequency and high tension current of about 7,000 volts. The power element of the plant consists of two sets of steam engines of 150 H. P. each, connected directly with the three-phase generators. A third set is kept in reserve.

From an architectural standpoint the plant is of special interest. All the large reservoirs for clarification, filters, as well as the columns and roofs of the buildings are built of concrete. This filtering and ozonating plant has fulfilled the hopes entertained as to the effectiveness of its purifying action from a physical and bacteriological standpoint. The dirty water from the Neva is transformed into a perfectly potable, pure, and transparent water, and is irreproachable from a sanitary standpoint, as it contains absolutely no typhoid fever, cholera, or other germs.

Two other installations of the same kind will be completed within this year for ozonizing the water supply of the City of Paris with a capacity of 46,000 cubic meters (13,000,000 gals.) each.

AERATOR NOZZLE TESTS

During the latter part of 1910 the Board of Water Supply of the City of New York conducted a series of tests to determine what type of nozzle would be most suitable for aerating the water at the Ashokan and Kensico reservoirs. The results of these tests are given in the 1910 report of Mr. J. Waldo Smith, chief engineer.

The results fully demonstrated, according to the report, the practicability of casting a thin shell with spiral vanes in one piece and determined the form of the nozzles to be used. Each nozzle consists of a cylindrical base surmounted by a conical tip. In the base are cast three vanes, equally spaced on circumference, and projecting nearly to the center of the waterway. At the bottom the vanes are parallel to the axis of the nozzle and above are curved to an inclination of about 60 deg. at the top. The function of the vanes is to set up a rotary motion in the water issuing in a solid stream at the tip and to aid in breaking it up promptly into drops. As in the earlier tests, it was observed that the rotary motion of the water gave the jets greater resistance to distortion from air movements, as compared with jets from nozzles without vanes. Three types of nozzles were constructed, a short-tipped, a long-tipped and one without tip; the base, including the vanes, was the same for all types.

Measurements of nozzle discharge were made by observing the drop of the water surface by a hook guage in the tank during fixed intervals, together with careful observations on the height, spread and general shape of the jet. Coefficients of discharge were computed and the effective head at the base obtained by a pressure gauge. The coefficient for the nozzles with tips, both long and short, was about 0.9 and for the nozzle without tip about 0.6 No advantage in shape, jet or coefficient was shown by the long-tipped or the short-tipped nozzle over the other. The nozzle without tip produced a marked division of the jets into three parts, which was especially manifest in the top of the jet. The report states that it is probable that placing the vanes a little deeper into the butt would produce a more regular form. A commercial nozzle gave a symmetrical jet with high coefficient, 0.96, but the spray was not as finely divided as the jets from the Board's nozzles, and for the proposed use the spread was considered undesirably greater.

PROPORTIONS OF EXPLOSIVE MIXTURES

Some interesting experiments to determine the limits of explosiveness of mixtures of air and acetylene have been made by Professor Eitner and the Bosnia Electric Company respectively. According to Professor Eitner, a mixture of air and acetylene is explosive when it contains a minimum of 2.9 per cent. acetylene to a maximum of 6.4 per cent. Above the latter degree the mixture ceases to be explosive. On the other hand, the electric company made experiments, not with small quanities like Professor Eitner, but with large amounts, a bell 11 cubic metres in capacity built with masonry being utilized. In this case the explosions took place with 1.5 to 3 per cent. acetylene. In a second series of experiments the constructions utilized were permeable to some extent, to allow communication between the interior and exterior air. To measure the explosive power a weight was placed against the door of the bell, and the quantity of acetylene was varied. With 2.5 per cent. acetylene there was a slight explosion, but with 2.6 the explosion was violent and accompanied by flames. Thus the lowest limit of explosiveness for mixtures of air and acetylene is 2.5 to 2.6 per cent. acetylene.

ASSUAN DAM PROGRESS

The work begun in 1907 of raising the level of the great Assuan Dam by 16 feet, and thus more than doubling its capacity, progressed during 1910 according to schedule. The dam as originally built had a capacity of 1,282,000,000 cubic yards of water, but with the improvements this will be increased to 3,008,400,000 cubic yards. The thickening work was finished from end to end in 1908 and 1909, and last year the locks, which had to be correspondingly raised, were completed to the new levels. An additional water height of 23 feet will be secured from the heightening of the masonry by about 16 feet. This is because the water surface of the original dam, when full, was 10 feet below the top of the masonry, because of the details of the ironwork construction. Experience has shown that such a large freeboard is not necessary and in the new dam the water will reach to within 1 meter of the roadway. It is believed that the additional supply of water will bring 1,000,000 acres of land in Egypt into cultivation.

THE BREATHING CAVE OF ARIZONA

Near Prescott, Arizona, there is a curious natural phenomenon known as a breathing cave. It is in the lava formation on a high tableland near Prescott. In a wall of this cave is a crevice which is probably three inches wide and several feet long. A visitor stands close to this crack. He feels a current of air rushing out of it. This is not so strange But if he waits long enough he will notice that the direction of the current has changed, and the air is being drawn into the crevice. A subterranean stream is given as the probable cause. Just how the flow of an underground river could cause the direction of the air current is not all at once evident, but it is assumed that there is a syphon action which alternately increases and reduces the air capacity of the cave by causing a rise and fall of the accumulated water in it.

NOTES

To thaw out frozen water pipes pack them with unslaked lime and wrap up in old rags or carpet. Pour water over the portions thus covered and the heat generated will melt the ice in the pipes.

The effect of vacuum upon the steam consumption of a turbine is strikingly shown by the reports of a recent test on a one thousand-killowatt machine in which the consumption increased forty per cent. with a decrease in vacuum from twenty-nine to twenty-one inches.

A movement is in progress for building in the Caucasus a tunnel longer than any yet constructed. It is to be double-tracked and 13 miles long, the Simplon tunnel being 12¼ miles. The estimated cost is $50,000,000 and the time required for construction seven or eight years, using for power the mountain rivers of the region.

The first underground pneumatic tube system constructed in this country was at Philadelphia in 1892. This was a 6-inch tube extending about five-eights of a mile from the central post-office to a sub-station. There are now 113½ miles of tubes in operation in five cities, viz.: New York 57¼, Philadelphia 20, Boston, 14, Chicago 18½, St. Louis 4.

It is proposed to connect Venice with the island of Lido by a tunnel 2¼ miles long under the lagoon. This island, a favorite resort of the Venetians, on account of its unrivaled beach and excellent sea bathing, is situated on the Adriatic. The terminus of the line would be in a central position, close to the Piazza di San Marco and the Riva degli Schiavoni, at about 26 feet below the sea level.

Measured by the capital invested, the cement industry is one of the world's three great extractive industries. In capital employed it apparently far outranks the gold-mining industry of the United States, including Alaska, as well as the copper industry. Only coal and iron stand ahead of it. The price of Portland cement in 1910 was as low as 73 cents a barrel in some places, the average for the United States being 89-1 cents a barrel. In 1890 the average price was over $2 a barrel and as late as 1903 it was $1.24 a barrel.

The American submarine Salmon has established a record for deep diving, which is said to exceed anything that has been hitherto accomplished in the American navy. During the early summer months the Octopus attained a depth of 125 ft. This has been exceeded by 19 ft. by the Salmon, which was submerged to a depth of 144 ft. off Prudence Island, and remained at that depth for twenty minutes.

A blow-out occurred in driving a compressed-air tunnel under Chelsea Creek, Boston, Mass., to carry one of the pipe lines for the distribution system of the Metropolitan Water Board. The tunnel line crossed a spot where a number of timber piles had been driven and withdrawn. The holes left when the piles were removed filled in with soft material, and when the subaqueous work crossed one of these holes the air blew out through the soft mud and water rose in the tunnel to the height of a man's chest.

As the oxygen percentage in air diminishes, the flame of a candle or lamp is affected in two ways. In the first place the light emittted steadily diminishes. Roughly speaking, the light of a candle or lamp diminishes by 30 per cent. with a fall of 1 per cent. in the oxygen percentage, and the flame will no longer burn when the oxygen has fallen from the normal (20.93 per cent.) to about 17.5 per cent. A further effect is that the flame becomes less and less stable and it is more and more easily blown out by any chance draft or movement.

At Notodden, Norway, in 1905, the first factory for manufacturing nitric acid directly from the elementary gases of the atmosphere was erected. In an enlarged form it now gives occupation to 500 workmen, and is daily demonstrating the remarkable possibilities of this new factor in chemical industry and in economic evolution. The factory furnishes all the nitrates required by Norway in agriculture and the arts, and is shipping constantly increasing quantities to foreign countries.

Almost perfect combustion can be obtained by mixing air in proper quantities with pulverized coal before the latter is introduced into the furnace. Less air is necessary than usual and the method greatly reduces the amount of heat carried away in escaping gases. The fuel is burned in suspension and the amount of unconsumed coal is very small. Coal dust which would otherwise be waste is thus made to do better work than a solid product costing much more. Another advantage is that the fire may be cut off very quickly, in a manner analogous to the turning off of gas from a jet.

At Elk City, Kans., the Missouri Pacific operates a pumping-station with a blind mule. The mule is left alone all day and goes around and around pumping water. When the tank is full the water splashes out on a sheet of zinc and the noise is the signal for the mule to stop. When a train comes along and takes water the mule begins to pump again until the water splatters. The owner of the mule got out last spring and worked against and helped beat the waterworks bonds at the election, because the construction of a waterworks system there would throw his blind mule out of work.

What is probably a Yorkshire record in coal mining, if not a world's record, has been achieved at the Hickleton Main Colliery. Recently the tonnage raised during six days reached a total of 26,986 tons, from a seam which is known as the Barnsley bed. Another record for the week ending Oct. 24 is 25,572 tons from the Crown Farm Pit of the Bolsover Colliery Company. This amount was mined in the time of five days and a half, each of 7 hours and 5 min. duration, only one shift per day being worked. It is said that this latter mine holds the world's record for a day's output, which is 4678 tons of coal.

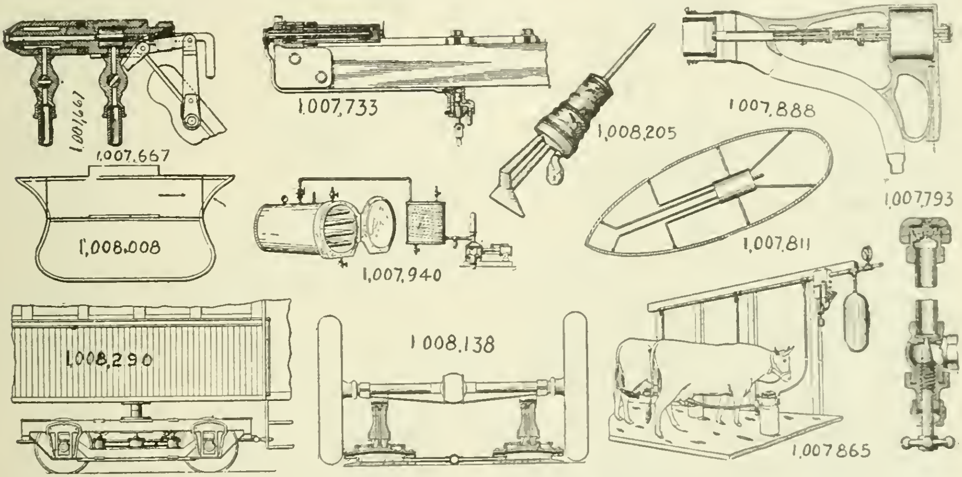
Admitting compressed air into the gas engine cylinder at the end of the exhaust stroke is proposed in a recent issue of the Zeitschrift des Vereines Deutscher Ingenieure. It is recognized that the residual of the burned gases remaining in the cylinder and mixed with the new charge dilutes the fresh mixture, impoverishes it, and generally interferes with the ignition of the charge, unduly elevates the initial temperature, predisposes the motor to premature explosion and affects the efficiency of operation. The author showed by means of diagrams and figures of a number of tests how the efficiency was increased as the result of the adoption of the valve which admits the air under pressure at the end of the exhaust stroke.

Hard steel is now cut with plain discs of mild steel rotated at high speed. The discs are of boiler plate quality steel and about ¼ in. thick. They are run at about a speed of 20,000 ft. a minute. It is said that one of the discs will cut through a heavy channel section of hard steel, 12 in. by 6¾ in., in 15 seconds. The disc remains cool while cutting because of its large surface area and small point of contact. The metal cut also remains cool for a similar reason, although at the point of contact with the disc the temperature is very high. The explanation of this apparently wonderful feat is that all the frictional energy of the disc is concentrated on an extremely small area of contact, and the cutting is accomplished apparently by local fusion.

A half part per million of iron in water is detectable by taste and more than 4 to 5 parts make a water unpalatable. In some mineral springs iron is the constituent which imparts a medicinal value to the water but ordinarily it is undesirable. More than 2.5 parts per million in water used for laundering makes a stain on clothes. Iron must be removed from water from which ice is made or a cloudy discolored product will result. An iron content of over 2 or 3 parts per million in water used in the manufacture of paper will stain the paper. Iron is harmful in water used for steaming, for it is in equilibrium with acids which inside the boiler become dissociated, with the result that the free acids corrode the boiler plates; but the amount of iron carried in solution by most waters is so small that the damage it does to steam boilers generally amounts to little.

A simple way of making telephone conversations more audible has been invented by Herr Petersen, a bank manager of Nykjobing, Denmark. On the principle that sound is more readily transmitted through rarefied air he has constructed an aparatus to warm the transmitter, whereby the air in it becomes thinner and the sound is intensified. Prof. Hanover of the

Danish Government telephone testing station, who has made extensive experiments with Petersen's apparatus, says in his report that the increase of sound obtained is remarkable. Telephone conversations between Copenhagen and Nykjobing, a distance of some seventy-five miles, could be clearly followed some distance away from the instrument. The inventor has applied for patents in different countries.



Pneumatic Patents, November 7.

The Secretary of the Treasury proposes to establish in the near future a pneumatic-tube service between the Bureau of Engraving and Printing and the Treasury Department, a distance of six city blocks, for the transportation of millions of dollars of paper currency, stamps and securities. The transportation is now accomplished by means of big steel vans, guarded by half a dozen armed men and a number of mounted guards. No attempt has ever been made to hold up these vans, but the underground tube is considered advisable, more for economic reasons than as a precaution against robbery.

Glass gradually softens as it is heated until further heating produces no further change. It does not become a freely flowing fluid at any temperature, but only a thick viscid substance which flows like cold molasses. Different kinds of glass begin to soften at widely different temperatures. Any glass may be heated probably 400 to 600 degrees F. without becoming soft.

Sewage ejectors operated by compressed air have been found serviceable in a number of English cities for raising the sewage of small districts too low to discharge into the main gravity system. At Frodingham, for instance, there are 90 houses with sewers draining to two chambers containing Coomb's pneumatic ejectors, each rated at 60 gal. Air is furnished by a motor-driven compressor provided with an automatic control. Current is obtained from the plant of a neighboring steel mill. When the pressure in the receiver of the ejector falls below that necessary for its operation, the motor is started automatically and continues in operation until the pressure has been raised to the upper limit is considered advisable for satisfactory performance of the ejector.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 7.

1,007,667. PAINT-SPRAYER. Frederick W. Ballard, Cleveland Heights, Ohio.

1,007,733. PNEUMATIC PICKING MECHANISM. Edgar Rhodes, Scholes, near Leeds, and Walter Rhodes, Leeds, England.

1,007,793-4-5. ATOMIZER OR SPRAYING DEVICE. Ernest H. Peabody, New York, N. Y.

1,007,811. FLUID-JET-PROPELLED VESSEL. Perrine G. Sommers, San Diego, Cal.

1,007,865. PULSATING DEVICE FOR MILKING APPARATUS. Ezra E. Good, Waterloo, Iowa.

1. In a milking apparatus, the combination with a pump pipe and a service pipe, of an automatic pulsating device connected between said pump pipe and said service pipe and operating intermittently to alternately connect said two pipes and to open said service pipe to the atmosphere, but at all times cutting off atmos-

pheric air from said pump pipe, a multiplicity of milk cans, milk conduits leading into said cans, independent air conduits leading from said cans to said service pipe, and devices applied to said cans, when air is admitted into said service pipe, by operation of said common pulsating device.

1,007,888. VACUUM CLEANING DEVICE. Pitman W. Parker, San Diego, Cal.

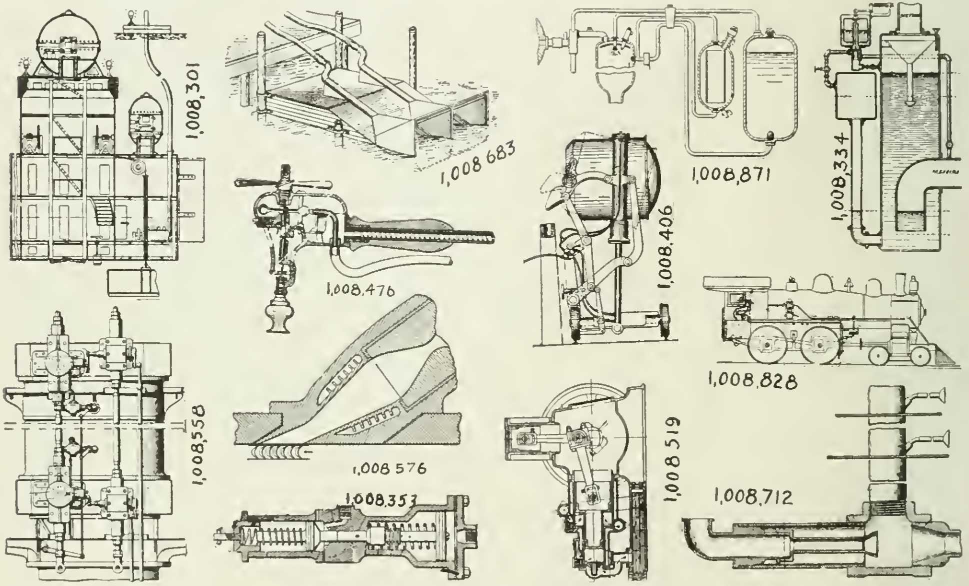
1. In a device of the character described, the combination with a vacuum tube, of a brush mounted at the mouth of said tube, and power means for imparting constant rotative and reciprocatory movement to said brush.

1,007,940. PROCESS OF DRYING EDIBLE PASTES. Frank M. Gregg, Cleveland, Ohio.

1. A process of drying edible pastes which consists in placing the pastes in a receptacle, exhausting the air from the receptacle and alternately raising and lowering the temperature while the reduced air pressure is continuously maintained.

1,007,955. COMPRESSED-AIR WATER-ELEVATOR. George S. Lane, Portland, Oreg.

1. In a pump, a cylinder, means for admitting water into said cylinder, means for admitting compressed air into said cylinder to displace the water and means for permitting the escape of air from said cylinder to permit water to enter the same, means for controlling the admission of air to and the escape of air from said cylinder, means for conveying the displaced water from said cylinder and a water motor operated by the water conveyed from said cylinder for operating said air admission and escape controlling means.



Pneumatic Patents, November 14.

1,008,008. CONSTRUCTION OF SHIPS. Arthur Clifton Caines, Swansea, England.

1,008,076. PORTABLE PNEUMATIC REVERSIBLE DRILLING-MACHINE. Charles Schofield, Newcastle-upon-Tyne, England.

1,008,123. AIR-CONDITIONING APPARATUS. Frank E. Donaldson, Palos Park, Ill.

1,008,138. LIFTING-JACK FOR AUTOMOBILES. George C. Hale, Kansas City, Mo.

1,008,205. VACUUM CLEANING APPARATUS. Julius Schirra, Pittsburgh, Pa.

1,008,228. METHOD OF MAKING PAPER. Philip Weston, Dalton, Mass.

1. The method herein described, of manufacturing paper having a thinned portion, which consists in removing from the web at the portion to be thinned, some of the material by the application of air pressure thereto.

2. The method herein described, of manufacturing paper having a thinned portion, which consists in removing from the web at the portion to be thinned, some of the material by the application of suction thereto.

1,008,290. AIR-CUSHION FOR VEHICLES. Reginald T. Verge, Halifax, Nova Scotia, Canada.

NOVEMBER 14.

1,008,301. SUBMARINE WORKSHOP. William H. Baker, Bridgeport, Conn.

1. A submarine structure of the character described provided with a bottom wall, a working floor of equal era with said bottom wall, the space between said bottom wall and floor forming a ballast compartment, a living room above said floor, means of supplying air to said living room, and centrally located gates in said bottom wall and floor, whereby when the pressure within the structure is equal to or greater than the water pressure operations may be carried on through said gates.

1,008,334. REGULATOR FOR GAS-WORKS. George C. Hicks, Jr., Connersville, Ind.

1,008,353. AUTOMATIC RETAINING-VALVE FOR AIRBRAKE SYSTEMS. Archibald Milligan, Ogden, Utah.

1,008,368-9. PNEUMATIC COW-MILKER. Joseph Ripczinske, Wausau, Wis.

1,008,406. PORTABLE FURNACE. Merrill Davis, Watertown, N. Y.

1. In combination, a tiltable and rotable furnace mounted on trunnions, a pair of *fluid pressure actuated hoists* for supporting and operating the furnace, an elevating mechanism for rotating the furnace during the pouring operations, and a valve carried by parts of said elevating mechanism adapted to control said hoists.

1,008,415. PNEUMATIC STRIKER APPARATUS. Macarius Maximilian Kastner and Conrad Katz, London, England.

1,008,476. FLUID-ACTUATED VIBRATOR. James B. Kirby, Cleveland, Ohio.

1,008,519. AIR-COMPRESSOR. Harry Edsil Barr, Erie, Pa.

1,008,558-9. BLOWING-ENGINE OR COMPRESSOR. Gustav B. Petsche, Philadelphia, Pa.

1,008,576. METHOD OF AND APPARATUS FOR ALTERING THE CONDITION OF GASES. Karl Ahlquist, Rugby, England.

1. The method which consists in taking a supply of relatively hot gas under pressure at low velocity, increasing the velocity and kinetic energy of the gas by expansion under suitable conditions, then cooling the gas, and utilizing the energy so obtained to compress the gas to a desired pressure by discharging it at the high velocity due to the previous expansion and cooling under such conditions that more or less of its energy of velocity is converted into pressure, substantially as described.

1,008,627. PNEUMATIC-DESPATCH-TUBE SYSTEM. Franklin H. Wolever, Chicago, Ill.

1,008,683. WAVE-ACTUATED AIR-COMPRESSOR. Enos A. Wall, Salt Lake City, Utah.

1,008,703. CAR-COOLING DEVICE. John Daniel Cunningham, Marietta, Ga.

1,008,712. HYDROVACUUM-CREATOR. James J. Gorman, Durango, Colo.

1,008,712. POWER SYSTEM. William E. Adams, Salem, Mass.

1. The combination with an internal combustion engine having an air jacket around its combustion cylinder, of an air compressor driven by the internal combustion engine and supplying air to the air jacket, an air reservoir connected with the air jacket to receive the heated and compressed air therefrom, and means co-operating with the air compressor for controlling a supply of compressed air from the reservoir to the air compressor to start the engine, substantially as described.

1,008,828. LUBRICATING SYSTEM. Walter A Keith, Los Angeles, Cal.

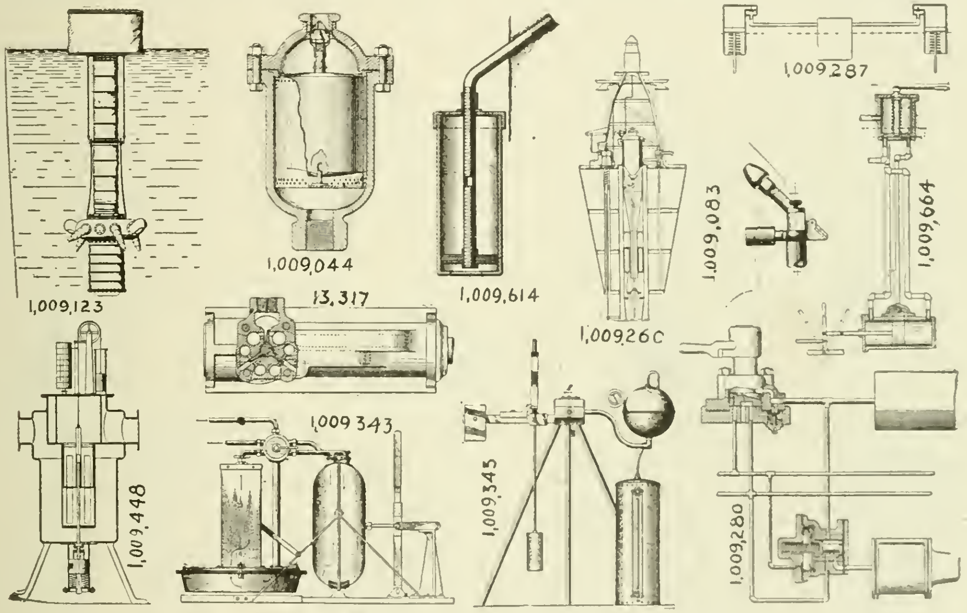
1. In a lubricating system, for railway rolling stock, means to distribute the lubricant on the wheel flange and the rail, comprising an oil tank in communication with an air supply under pressure having an air-regulating valve thereon, a discharge pipe extending from the oil tank, a spray valve connected with said oil discharge pipe, a pipe connecting the spray valve with the air supply, and a nozzle extending from the spray valve and adapted to spray the lubricant on the wheel flange and the rail.

1,008,865. VACUUM ATTACHMENT FOR CARPET-SWEEPERS. Julius Schirra, Pittsburgh, Pa.

1,008,871. MEANS FOR INCREASING ENERGY OF STORED COMPRESSED AIR OR OTHER GAS CAPABLE OF SUPPORTING COMBUSTION. William Horace Sodeau, Newcastle-upon-Tyne, England.

1. Apparatus for increasing the energy of stored compressed air comprising in combination a combustion chamber into which said air is admitted, a fuel reservoir and a supply of vaporizable liquid, said vaporizable liquid on its passage to the combustion chamber being divided into two streams one of which displaces from the fuel chamber an amount of fuel proportional to the amount of vaporizable liquid flowing directly to the combustion chamber.

1,008,884. AUTOMATIC SEWAGE-EJECTOR. William P. Anderson, New York, N. Y.



Pneumatic Patents, November 21.

NOVEMBER 21.

1,009,044. VENT-VALVE FOR WATER OR OTHER LIQUID CARRYING CONDUITS. Edward Burgess, Brixton, London, England.

1,009,083. AIR-SUPPLY ARMOR. Christopher McNamee, New York, N. Y.

1. In a device of this character, the combination of a body garment provided with an air-chamber, means for supplying air thereto, a conduit for conveying the air from the air-chamber, and a respiratory device connected to said conduit and comprising a casing, two nostril entering tubes carried thereby, and a valve controlled mouth-piece said mouth-piece and tubes being separate from each other and out of communication with each other.

1,009,123. APPARATUS FOR RAISING SUNKEN VESSELS. Charles Williamson, Norfolk, Va.

1,009,205. AIR-PURIFYING APPARATUS. Wellinton P. Winter, Toledo, Ohio.

1,009,220. DRESSING-DELIVERING MECHANISM. Charles F. Burkhart, Buffalo, N. Y.

1. In a device of the class described, the combustion with a foot rest, of a dressing tube movable past the same, means for supplying dressing to said tube, an air blast tube discharging across the end of said dressing tube and directing its discharge toward a shoe on the foot rest, means for normally closing said dressing tube, and means for opening the dressing tube.

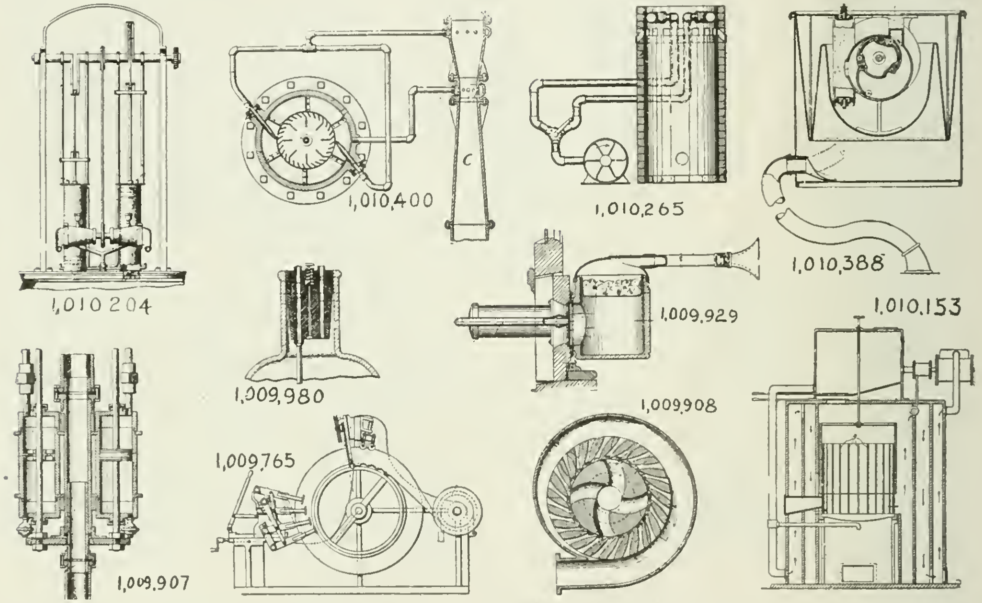
1,009,260. VACUUM-GENERATING WAVE-MOTOR. GUSTAF VON POST, Stockholm, Sweden.

1,009,286. DUPLEX-PRESSURE EMERGENCY AND STRAIGHT-AIR BRAKE. JOHN S. CUSTER, Pittsburgh, Pa.

1,009,287. COMPRESSED-AIR SUSPENSION FOR VEHICLES. LEON DELPEUCH, Neuilly-sur-Seine, France.

1,009,316. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHESTER S. JENNINGS, Boston, Mass.

1,009,343. REGULATOR FOR PUMPING-ENGINES. WILLIAM K. RICHARDSON, Leavenworth, Kans.



PNEUMATIC PATENTS, NOVEMBER 28.

2. The combination of a rock-lever, a receptacle carried thereby containing air under pressure, means for weighting the receptacle by conducting water thereto to balance or overbalance the opposite end of the lever or for lightening the receptacle by conducting water therefrom until it balances or is of less weight than said opposite end of the lever, a frame pivotally carried by the lever, and means for maintaining said frame in an upright position, irrespective of the rocking movements of the lever.

1,009,448. AUTOMATIC RECORDING APPARATUS FOR MEASURING GASEOUS FLUIDS. CARL FRIEDRICH SIMON, Stolberg, Germany.

1,009,498. PNEUMATIC SPRING. ADOLPH W. FRITZ, Burlington, Iowa.

1,009,499. PNEUMATIC CLEANER. CHARLES BURDETTE GILMORE, Bloomington, Ill.

1,009,641. TURPENTINE-CUP. HERMAN H. BOYER, Pensacola, Fla.

1,009,664. CONTROLLING MECHANISM FOR BOATS. EDWARD HEFTY and ALFRED B. LAMBERSON, Portland, Oreg.

13,317. (Reissue). VALVE-MOTION FOR ROCK-DRILLS. LEWIS CONDICT BAYLES, Easton, Pa.

NOVEMBER 28.

1,009,723. AIR-REGULATING DEVICE FOR OIL-BURNING FURNACES. KNUT M. DAHL, San Francisco, Cal.

1,009,765. MACHINE FOR MANUFACTURING PNEUMATIC TIRES. ALPHONSE MATHERN, Berlin, Germany.

1,009,782. VACUUM EVAPORATING APPARATUS. CHARLES ORDWAY, New York, N. Y.

1,009,907. SUCTION-HOSE COUPLING. GEORGE M. KESSLER, Gregson, Mont.

1. The combination with an upright sleeve adapted to be connected at its upper end with a pump, cylinders at opposite sides of said sleeve, pistons therein, piston rods depending from these pistons through the lower heads of the cylinders, and connections for moving the pistons in either direction by fluid-pressure; of a yoke connecting the piston rods and having a notch in its front edge, a pipe removably engaging said notch and connected at its lower end with a hose, and a cup surrounding the pipe and adapted to make a tight joint with the lower end of the sleeve when it is elevated by the rise of said yoke.

1,009,908. VACUUM-PUMP, OR COMPRESSOR. JOHN A LAFORE, Cynwyd, Pa.

1,009,929. DEVICE FOR THE ADMINISTRATION OF MEDICATED OXYGEN. GEORGE W. PHILLIPS, New York, N. Y.

1,009,980. AIR-PRESSURE CORK. JOSEPH S. LEISURE and PERL J. ROBINSON, Ingleside, Neb.

1,010,153. HOT-AIR ENGINE. JOSEPH KUHAJDA, New York, N. Y.

1,010,204. MILKING-MACHINE. THEODORE UMRATH, Chicago, Ill.

1,010,265. BLAST-FURNANCE. CHARLES FRANCIS JENKINS, Washington, D. C.

1,010,388. VACUUM-PRODUCING MACHINE. JAMES B. KIRBY, Cleveland, Ohio.

1,014,400. FLUID-METER. EDGAR P. COLEMAN, Buffalo, N. Y.

6315

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XVII FEBRUARY, 1912 No. 2

A MACHINE SHOP WITHOUT COMPRESSED AIR

BY FRANK RICHARDS.

A month or two ago I made a little call at a machine shop with which I was quite familiar for several years ending about a quarter of a century ago. It is not what you might call a big shop; I should guess that it employs less than a hundred hands all told. It was a prosperous business when I knew it intimately—it was growing in those days—and its prosperity has not deserted it in all these years, but it has done little if any growing since.

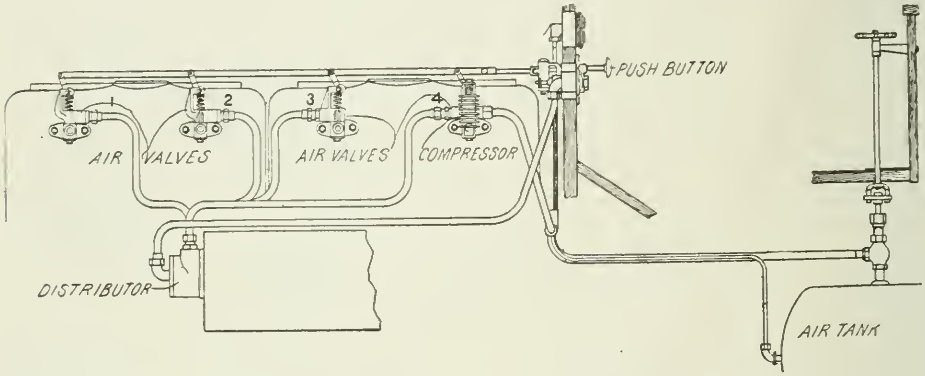
I was talking with the superintendent and among other things I said something about compressed air and the multiplicity and variety of employments it has in these days—but I used only the handy words of everyday talk—when it came out, really to my surprise, that this shop has absolutely no compressed air in use nor any means of supplying it. I said to myself at once: "That explains why the concern hasn't been growing." A shop needs compressed air to breathe to develop in it full activity and push. The absence of the compressed air implies the lack of other facilities of business which alert management, not necessarily and consciously "scientific," would be bringing together for the increase of efficiency and output.

Why, I thought in a minute as I was talking, there is a single job in that shop which alone would pay for the installation and maintenance of compressor, receiver, piping and all appurtenances. A single air hoist would do it. There is a special machine that they build in considerable quantities and which in the assembling involves the hoisting of two or three tolerably heavy pieces; and then in testing these machines there are peculiar conditions which make it necessary to take each apart and put it together two or three times. Think of doing the hoisting with a chain hoist and trolley on a short run of over-head track. The use of this one hand operated hoist, with all which it implies as to means and methods, necessitates an additional helper on the job, and it means also much slower movements for the hoisting and lowering operations. Then they have some large tools, a big planer, some big lathes, a boring mill and no air hoists for them. This is saying nothing about the pneumatic tools, hammers, drills, etc., which the shop would have use for, and the special applications of the air which would inevitably develop if the air was handy.

Not to go into figures in detail, a cost of one dollar a day would liberally cover the interest upon the cost of installation, the maintenance and the power cost of operating, a compressed air equipment for such a machine shop as we have here in mind. Where is the shop which can afford not to spend the dollar? There is absolutely not the slightest suggestion of experiment in the matter, as the value of compressed air as a shop helper has been demonstrated wherever it has been employed. Its record in this respect is unique. No one has ever heard of any shop once adopting the use of compressed air and afterwards discarding it.

There are in fact comparatively few shops now which have not an air compressor as a component of their equipment, and where any such shops are found they are never railroad shops, because there the handy air brake pumps, which are far from the ideal for general shop use, have given them all an opportunity of sampling the compressed air service, and the air itself has done the rest, so that the railroad shops are now among the best customers of the builders of up-to-date compressors. The machine tool builders now assume that there is always a supply of compressed air in the machine shop, and they design their tools with air actuated movements which increase their efficiency and speed of operation. The shop without the air supply and the manager who does not *think* compressed air is shut off from the use of these improved tools.

Compressors are now on the market with unlimited range of capacities, adapted to any mode of driving, entirely automatic and working with all possible economy of power. In urging their wider employment I must feel that I am aiming to promote the interest of the machine shop proprietor more than that of the compressor builder. From *Machinery;* with additions by the writer.



SKETCH OF COMPRESSED AIR AUTO STARTER.

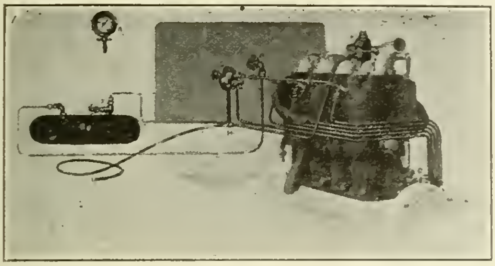
COMPRESSED AIR AUTOMOBILE STARTERS

It is a pleasure to us to speak of the renewal of youth which has come to the *Scientific American*. Although it is now in its sixty-eighth year we do not know any publication which is more completely up to date. Every issue is filled with live and valuable matter while its special issues once a month are notable for their excellence and completeness. From its recent automobile number we reproduce the following having to do with one of the most important of the later developments in automobile design.

The majority of leading motor car manufacturers have adopted automatic starters for their 1912 or 1913 models, and specialty companies are in the market with self-starters of half a dozen or more distinct types. Inasmuch as most of these are quite new and almost unknown to motorists in general, an attempt will be made to present briefly their different characteristics and methods of operation.

The reputation of one of the real pioneer automobile companies is staked on the success of the air pressure type and another company almost as old and with a very large annual output of cars has indicated equal confidence in the electric system.

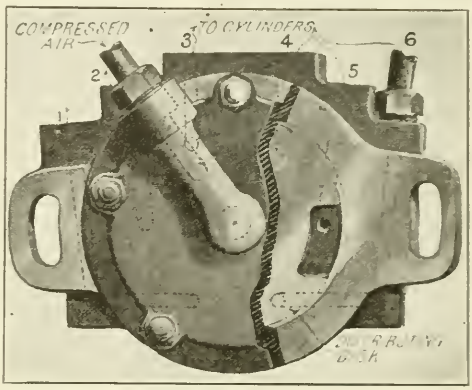
In their main features the pneumatic starters are so much alike that one description will fit all except for minor constructional differences. The initial movement of the pistons necessary to create suction and compression in one or more of the cylinders is effected by the expansion of compressed air. This is admitted first to that cylinder in which the piston is on the explosion or working stroke. The pressure, which may be from 20 to 150 pounds or more per square inch, pushes this piston down, thereby causing the piston that is on the suction stroke to draw in a charge of fresh gas from the carbureter. At the end of the stroke the pressure is automatically transferred by means of a distributor or selector to the second piston ready for the working stroke, and as this descends it raises the one that was previously on the suction stroke and compresses the fresh charge, which is fired automatically by the regular ignition system when compression is completed. The engine is then ready to run on its own power, and the starter can be shut off. But if the engine fails to start on the first or second turn, the crankshaft can be revolved a large number of times before the air pressure is exhausted. With some systems the engine can be started 100 times, it is said, without renewing the pressure.



AIR RECEIVER AND CONNECTIONS.

Only the pressure of a foot button or push valve on the dash is needed to start the engine with this system; everything else is automatic. The shock of starting "on the spark" is avoided because, as in hand cranking, the reciprocating and rotating parts are set in motion gently by the air pressure before ignition of the first charge occurs. Operation is practically noiseless and, if the air passages are large, the action should be fast enough to insure ignition with a battery. One manufacturer asserts that the only time when it will fail to start an engine that is properly adjusted and in good running condition is when the crankshaft stops on a dead center. This does not occur often with the ordinary four-cylinder engine and cannot happen with six-cylinder engines.

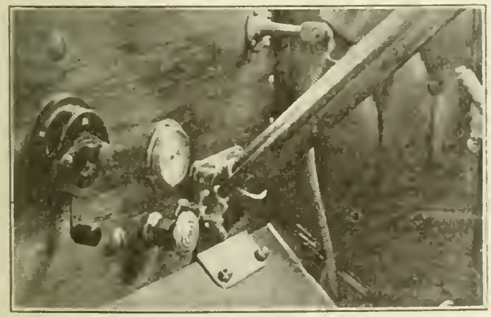
The mechanism employed consists of a compressor driven by the engine, a pressure tank carried under the car, a pressure gage on the dash, a push valve on the dash or footboard, a distributor or selector driven by the engine, air valves opening into the combustion chambers of the cylinders and the necessary copper piping and brass unions to connect these elements in the proper way.



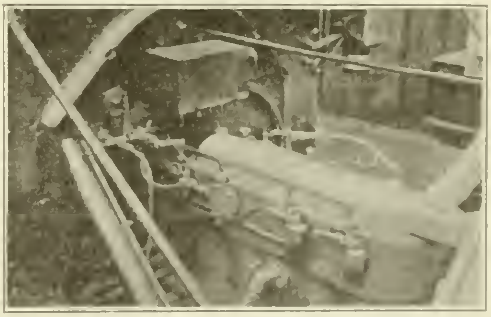
THE DISTRIBUTOR.

Usually the compressor is a small air-cooled or water-cooled cylinder with a double piston so attached to the head of one of the engine cylinders that its lower barrel communicates with the combustion chamber while the upper barrel has a small valve opening to the atmosphere. When the engine is running, each explosion in that cylinder produces an impulse of the plunger in the compressor and causes the chamber communicating with the atmosphere to compress a small quantity of air and force it through a tube to the storage tank. From five to ten minutes suffices to fill the tank, and when a predetermined pressure has been attained—say 150 to 175 pounds—the back pressure automatically stops the operation of the compressor until the pressure has been reduced. The pressure is indicated at all times by the gage on the dash and should be maintained preferably at 60 pounds or more, although it is possible to start the engine with as little as 20 pounds.

When the push button in front of the driver is pressed to start the engine, it releases



REAR OF DASH.



ENGINE WITH COMPRESSOR AND VALVE

some of the air from the tank and this passes to the distributor, whose function is to admit the air only to the cylinder that is on the working stroke, thus preventing the starter from working against compression. The device consists of a rotating metal disk or a sleeve having a slot that uncovers openings to tubes leading to the several cylinders in the order of their firing. It is geared to the cam shaft or magneto shaft so that it operates in perfect time with the engine. It runs continuously and necessarily stops, when the engine stops, in such position that the slot uncovers the opening that leads to that cylinder whose piston has last completed the compression stroke. As the crankshaft revolves under the pressure, the distributor uncovers the pipe to the next cylinder in order of firing and so on until ignition occurs and the engine begins to run on gas.

To prevent back pressure in the air pipes on the explosion strokes and consequent loss of power in the engine, a valve is introduced where each tube is connected to its cylinder. These valves are held closed normally by springs, but are all opened simultaneously by a buss bar or rod that connects them together and extends back to the push on the dash so that the same pressure that releases the air also opens the valves to admit it freely to the cylinders. The valves close automatically when the push is released.

Use of this system on a car obviates the necessity of providing a power tire pump for inflating tires or expending energy and patience over a foot pump. A flexible hose with a tire valve connection at its free end and a stop cock at the other end where connection is made, can be attached to the compressed air tank to be used for inflating tires, as is done by one of the motor car makers.

THE BRITISH OXYGEN INDUSTRY

A British oxygen company states that it has decided to erect an oxygen factory in Sheffield, where it is considered the growing demand for oxygen in connection with metal cutting warrants this extension. When the Sheffield plant is completed the company, which in 1908 had only three factories (London, Birmingham and Manchester), will possess eight factories in the United Kingdom, all situated in centers where the demand for oxygen is important—at London (Westminster and Greenwich), Birmingham, Cardiff, Manchester, Sheffield, Newcastle, and Glasgow. These extensions are entirely due to the demand for cheap oxygen in connection with oxy-acetylene welding and oxygen metal cutting. In view of the heavy freight charges on gas cylinders conveyed by rail, it is obvious that local sources of supply must tend to reduce the price of oxygen to the consumer. All the company's plants are of the modern liquid-air type, producing oxygen of a high degree of purity, and when the Sheffield plant is in operation their total output will be about 300,000 cubic feet a day. This supply is largely in excess of the present demand, but it is anticipated that this quantity may ultimately be required if the use of oxygen for metal cutting extends. The present average price of oxygen, supplied in cylinders, for industrial purposes is about £2 ($9.73) per 1,000 cubic feet, but reductions are expected if the demand increases.

EQUAL WORK IN TWO-STAGE AIR CYLINDERS

By J. William Jones.*

Until about ten years ago the average terminal gage air pressure required of an air compressor did not exceed seventy or eighty pounds per square inch; consequently single-stage compression was almost universally employed. The use of higher pressures in compresed air service brought about the employment of stage compression which has proved to be more economical and practical for all pressures exceeding seventy pounds per square inch. It is safe to state that about eighty to ninety per cent. of all the compressors sold in this country during the past five years have what is called compound or two-stage air cylinders. The majority of these were probably built for discharge pressures of about one hundred pounds per square inch, but there seems to be no uniformity among the users of compressed air as to what constitutes a standard pressure for a certain line of work.

The different purposes for which compressed air is utilized, naturally demand various discharge pressures. The constantly increasing application of compressed air to the numerous purposes for which it is adapted at the present day requires air pressures in two-stage

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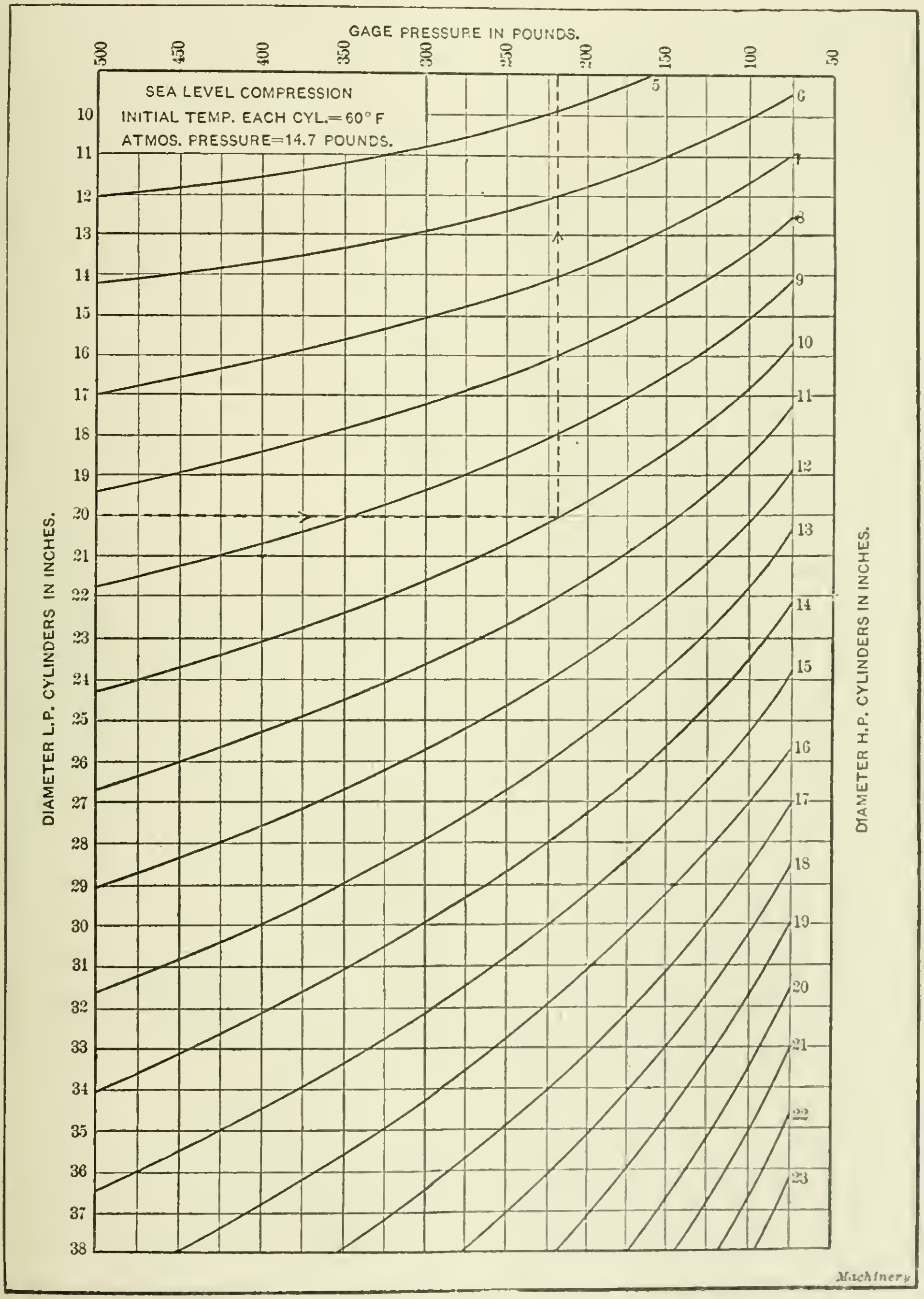
*Ingersoll-Rand Company, Painted Post, N. Y.


GAGE PRESSURE IN POUNDS.
500
450
400
350
300
250
200
150
100
50
SEA LEVEL COMPRESSION
INITIAL TEMP. EACH CYL.=60° F
ATMOS. PRESSURE=14.7 POUNDS.
DIAMETER L.P. CYLINDERS IN INCHES.
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DIAMETER H.P. CYLINDERS IN INCHES.
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23
Machinery

FIG. 1.

machines varying all the way from seventy to five hundred pounds per square inch. Where one shop uses eighty pounds pressure per square inch for the operation of pneumatic tools it will be found that another uses ninety pounds, and still another one hundred pounds; one contractor will want to carry a line pressure of one hundred pounds for operating his rock drills and another will insist that he must carry one hundred and ten pounds. In the oil fields, for pumping oil, pressures ranging all the way from one hundred and fifty pounds up to five hundred pounds are required. New fields requiring higher pressures than those used heretofore for the ordinary lines of work for which compressed air has been the chief motive power are constantly presenting themselves.

In perusing the catalogues of the larger builders of compressed air machinery, it will be noted that they are now listing medium duty and high duty compressor sizes, the former having the cylinders proportioned correctly for pressures ranging from eighty to one hundred pounds and the latter for pressures ranging from one hundred to one hundred and twenty-five pounds. In addition to the above they carry a line of cylinder sizes which can be readily applied to the various compressor types for pressures ranging all the way from one hundred and fifty to five hundred pounds per square inch.

To know just what compound cylinder combination should be used for a specified terminal gage air pressure, requires some knowledge of the theory of air compression as well as a somewhat complicated arithmetical computation. The theory is not always easily remembered and errors are liable to occur in making lengthy computations. The accompanying diagrams solve the problems at a glance, requiring no knowledge of the theory of compression and no computations whatever.

Referring to Fig. I, the curves of which have been plotted for sea level conditions, let it be assumed that it is desired to know at what terminal gage air pressure the total work will be equally divided between two compound air cylinders of certain dimensions. Assuming that the compressor has a low pressure air cylinder twenty inches diameter and a high pressure cylinder ten inches diameter, the stroke being common to both cylinders, the low pressure cylinder diameter, twenty inches, will be found along the left-hand margin. Now projecting this point along the horizontal line in the direction shown by the arrow until the dotted line intersects with the curved line marked ten inches, and thence in a vertical direction until the upper margin is reached, the answer is found which in this case is two hundred twenty pounds per square inch; that is, an air compressor having a low pressure cylinder twenty inches diameter and a high pressure ten inches diameter with the stroke the same in both cylinders will have the total horsepower equally divided between the two cylinders when compressing to a final gage discharge pressure of two hundred twenty pounds per square inch, assuming the initial temperature to be the same in each cylinder which is equal to perfect intercooling between the two stages.

On the other hand, if it is desired to know what cylinder combination should be used for a specified terminal pressure, it is only necessary to first compute the diameter and stroke of the low pressure cylinder in relation to the desired piston displacement and then, starting at the upper border line at the required discharge pressure and at the left-hand border line at the correct low pressure cylinder diameter, note near what high pressure cylinder curve these two points cross when projected towards the curves. The above rules apply for any cylinder combination which the charts show and on any one of the three charts which have the curves plotted for sea level, five thousand and ten thousand feet altitude, respectively.

The formula for determining the final gage air pressure per square inch of any two-stage compressor in order to have the total horsepower required divided equally in each cylinder, is as follows:

$$P_3 = \left[\left(\frac{D^2}{d^2} \right)^2 \times P \right] - P$$

in which

P=atmospheric pressure in pounds per square inch.

P_3=terminal gage air pressure in pounds per square inch.

D=diameter of low pressure air cylinder in inches.

d=diameter of high pressure air cylinder in inches.

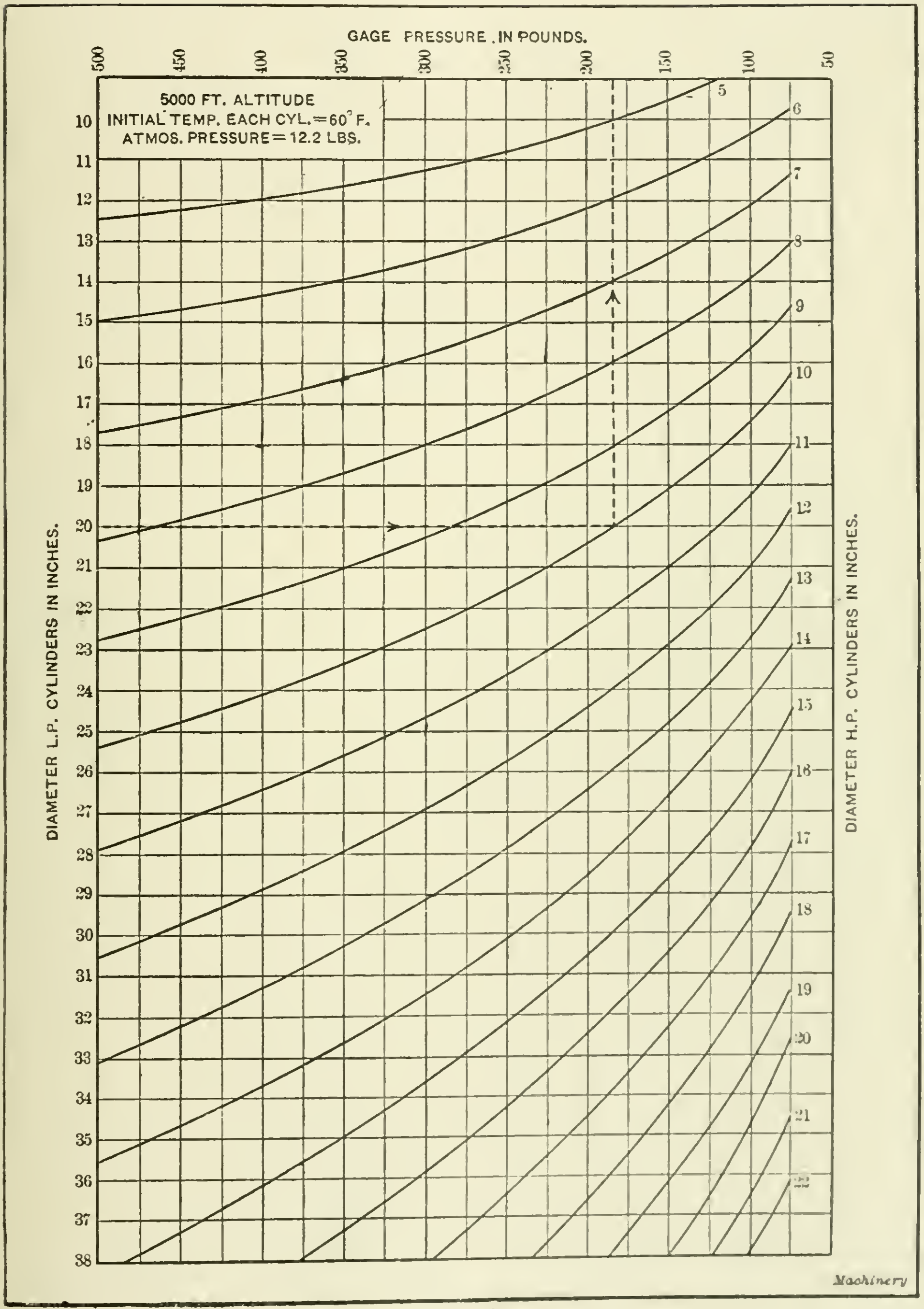
GAGE PRESSURE, IN POUNDS.
500
450
400
350
300
250
200
150
100
50
5000 FT. ALTITUDE
INITIAL TEMP. EACH CYL.=60° F.
ATMOS. PRESSURE=12.2 LBS.
DIAMETER L.P. CYLINDERS IN INCHES.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
DIAMETER H.P. CYLINDERS IN INCHES.
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
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FIG. 2.

Example: Having a low pressure cylinder 20 inches diameter and a high pressure cylinder 10 inches diameter, it is required to find the terminal gage air pressure per square inch (P_3) at which the work is equal in each cylinder at sea level; the atmospheric pressure being 14.7 pounds per square inch.

$$P_3 = \left[\left(\frac{20^2}{10^2}\right)^2 \times 14.7\right] - 14.7 = 220.5 \text{ pounds}$$

In the accompanying table are given the values of $\frac{D^2}{d^2}$ for various gage pressures from 75 to 500 pounds inclusive. This information is of value in computing cylinder sizes when the terminal gage air pressure is a settled fact. The diameter and stroke of the low pressure cylinder having been first determined relative to the required piston displacement, the diameter of the high pressure piston required to divide the load equally between the two cylinders is found by dividing the factor opposite the known gage discharge pressure into the area of the low pressure piston, to obtain the area of the high pressure. For 200 pounds final discharge pressure at 5000 feet altitude, the factor in the table is found to be 4.17. Assuming that a 25-inch diameter low pressure cylinder is required to give the necessary piston displacement, the area of the high pressure cylinder would be equal to the area of the low pressure, or 490.87 square inches, divided by 4.17 which gives a high pressure cylinder having an area of 117.6 square inches. This area is equal to a diameter of approximately 12¼ inches.

Gage Pressure, Pounds	Sea Level	5000 Feet	10,000 Feet	Gage Pressure, Pounds	Sea Level	5000 Feet	10,000 Feet
75	2.47	2.67	2.91	185	3.69	4.01	4.41
80	2.54	2.74	2.99	190	3.73	4.06	4.46
85	2.60	2.82	3.08	195	3.77	4.11	4.52
90	2.67	2.89	3.16	200	3.82	4.17	4.57
95	2.73	2.96	3.24	210	3.91	4.26	4.68
100	2.79	3.03	3.31	220	3.99	4.36	4.78
105	2.85	3.09	3.39	230	4.07	4.45	4.89
110	2.91	3.16	3.46	240	4.15	4.54	4.99
115	2.97	3.22	3.53	250	4.23	4.63	5.08
120	3.02	3.29	3.60	260	4.32	4.72	5.18
125	3.08	3.35	3.66	270	4.39	4.81	5.28
130	3.14	3.41	3.74	280	4.47	4.89	5.37
135	3.19	3.47	3.81	290	4.54	4.97	5.46
140	3.24	3.52	3.87	300	4.62	5.06	5.56
145	3.29	3.58	3.93	325	4.80	5.25	5.77
150	3.35	3.65	3.99	350	4.98	5.44	5.98
155	3.40	3.70	4.06	375	5.14	5.62	6.18
160	3.45	3.75	4.12	400	5.30	5.80	6.38
165	3.50	3.80	4.18	425	5.46	5.98	6.57
170	3.55	3.86	4.24	450	5.62	6.15	6.75
175	3.59	3.92	4.30	475	5.77	6.31	6.94
180	3.64	3.97	4.36	500	5.92	6.48	7.12

D = diameter low pressure air cylinder.
d = diameter high pressure air cylinder.
Atmospheric pressure at sea level = 14.7 pounds per square inch.
Atmospheric pressure at 5000 feet = 12.2 pounds per square inch.
Atmospheric pressure at 10,000 feet = 10.07 pounds per square inch.

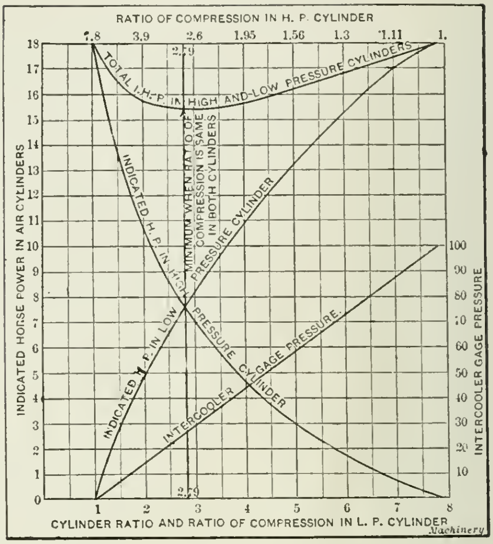

FIG. 4.

In theory the cylinders should be proportioned exactly in accordance with the above, all of which is based on the assumption that the intercooler reduces the temperature of the air to the original between the two stages. The intercoolers of the present day, however, can not be relied upon to do this, which means that, with the cylinders proportioned as above stated, the low pressure or intake cylinder would be required to do more than its share of the work due to the higher mean pressure in the cooler, on account of the thermal conditions not being perfect. It is, therefore, good practice to make the high pressure cylinder diameter a little in excess of the actual figures which the theoretical conditions show; that is, if the computation for the high pressure cylinder should result in a diameter of 9½ inches it would be good practice to call this diameter 10 inches.

Although the rules already mentioned are theoretically correct, it is possible to vary the proportions of the cylinders to some extent for any specified pressure without unbalancing the work to any appreciable amount. To show the actual relations between the horsepower, etc., in the two cylinders, the curves in the ac-

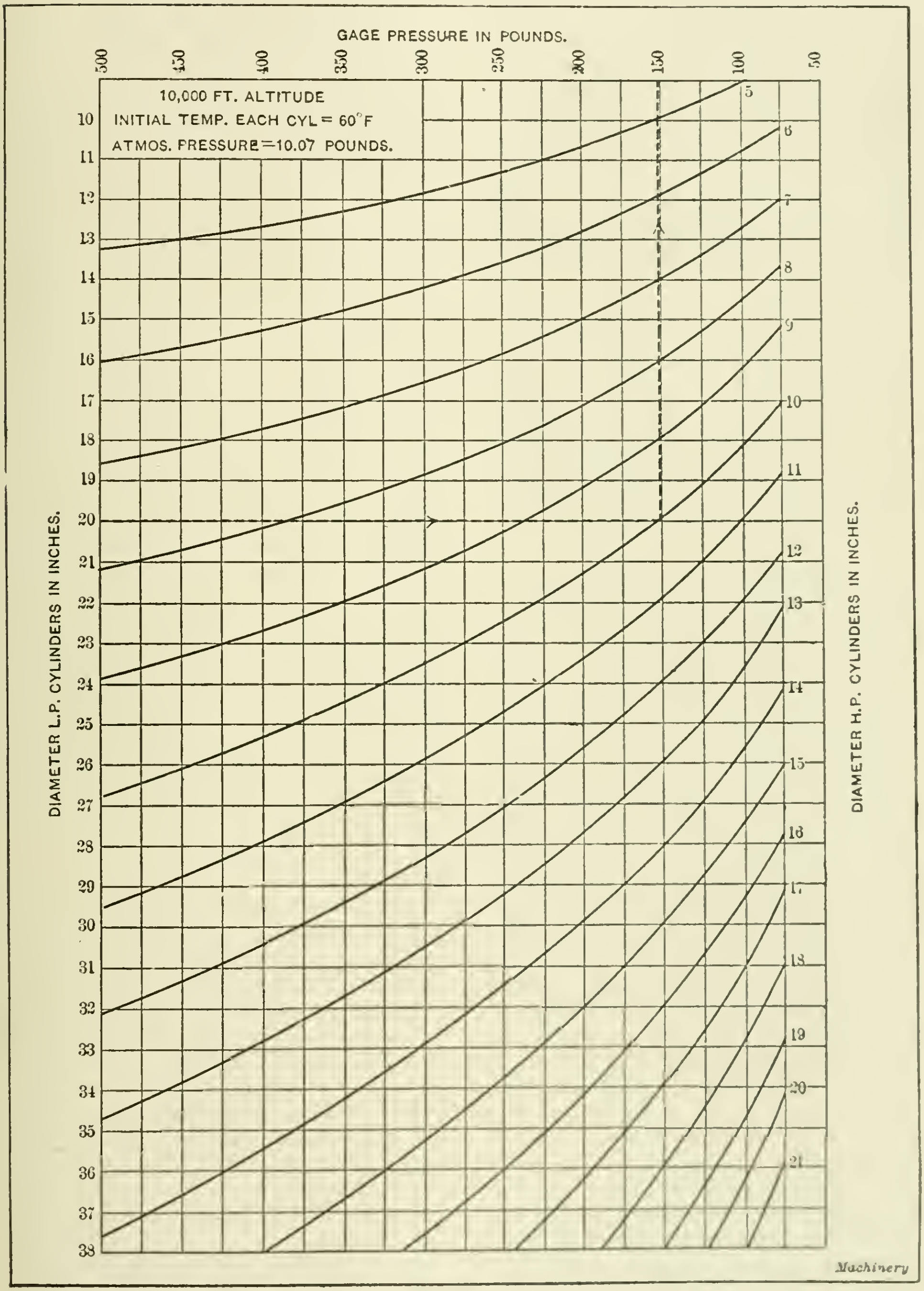

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FIG. 3.

companying chart Fig. 4, have been plotted. These curves show the theoretical horsepower required in either the high or low pressure cylinder when compressing to 100 pounds terminal gage pressure with different cylinder ratios. Also a curve for this pressure has been plotted showing the combined horsepower of the two cylinders with these different cylinder ratios. It will be noticed that the minimum horsepower is required when the ratio of compression is the same in both high and low pressures cylinders. In this case the ratio of compression should be 2.79, which requires 7.72 horsepower in each cylinder when compressing 100 cubic feet of free air per minute to 100 pounds gage pressure, or the minimum total of 15.44 horsepower in the two cylinders. This ratio of compression when the same in both cylinders, is also the theoretical ratio of cylinder volumes. The values $\frac{D^2}{d^2}$ already referred to in the accompanying table, are nothing more nor less than the correct cylinder ratios for the pressures listed and at the different altitudes specified in this table.

In observing the curve showing the total horsepower in the chart it will be noted that it is very flat at the point of minimum horsepower. This means that it is possible to vary the cylinder ratio to a greater or less degree than the theoretical conditions shown without affecting the total horsepower to any great degree. A safe figure would be about ten per cent above or below the theoretical, preferably below for the reasons already assigned to imperfect intercooling. A good rule for compressors delivering air at 100 pounds gage pressure is to make the area of the low pressure piston two and one-half times the area of the high pressure.

The intercooler pressure naturally varies according to the cylinder ratio; to show these pressures, a curve Fig. 4, for the different cylinder ratios has been included.

[The above we reprint from the issue of *Machinery* for January, 1912. The three large diagrams here reproduced belong to the valuable series of data sheets issued in connection with that publication.—Ed. C. A. M.]

One pint of gasoline will make two hundred cubic feet of air explosives when the gasoline is turned into vapor.

SUBAQUEOUS METHODS FOR DRIVING A LAND TUNNEL

Compressed-air methods have been in use for several months in driving through a soft, running material in a long section of the Big Savage tunnel on the new Western Maryland Railway extension between Cumberland, Md., and Connellsville, Pa. This tunnel is on the summit of the Allegheny Mountains, at an elevation of 2,350 ft. Construction was started on it about 15 months ago, the work being conducted from both portals in top headings in rock. The west heading had progressed about 640 ft. when on Dec. 19, 1910, a rapid inflow of soft, wet material blocked it and prevented further progress until an air lock was installed and pneumatic methods were introduced. These methods have coped with the situation successfully and the difficulty is practically past at the present time.

The tunnel is a single-track structure, 17 ft. in width in the clear, with a full semi-circular arch on a radius of 8 ft. 6 in., with the springing line 15 ft. 3 in. above subgrade. The length is 3,275 ft. The rock encountered in the first 600 ft. on the west and in all of the work on the east has been a hard gray sandstone, bedded in thick layers dipping toward the east at an inclination of about 2 to 1. It was originally intended to drive both headings through to a meeting before starting the bench, these headings being the full arch section above the spring line.

INRUSH OF SOFT MATERIAL.

Just previous to the time of encountering the soft material, the west heading was in rock so hard that practically a full shift was required to drill a round of holes. On Dec. 19, the holes were drilled and loaded as usual, but following the shot, soft mud and sand rushed in from the top and flooded the heading back to a point about 200 ft. from the face. This material was a mixture of fine water-bearing sand and finely-divided disintegrated rock, which was accompanied by so much water as to make it flow very easily.

It was at first thought that a soft pocket had been struck, so the heading was cleared as far as possible and work was resumed in the soft material, a pilot drift being driven at the crown to ascertain the conditions ahead. This drift required full box timbering and breast boards with straw packing, and progress was very laborious. The soft material ran into the heading practically as fast as it was removed, and the pressure from above became so great as to displace and break the drift timbering. As soon as a small amount of headway was gained with this drift, it was enlarged and timbered closely with wooden voussoirs. After continued efforts to advance in this way, which netted only about 15 ft. total gain in a period of more than a month, it became apparent that satisfactory progress could not be made by this procedure and pneumatic methods were determined upon. During this time the soft material and water continued to flow in and former springs on top of the mountain were observed to have ceased flowing. On Feb. 1, at a time when the frost was beginning to leave the ground, a large cave-in occurred in the ground surface over the tunnel, a hole about 20x20x16 ft. appearing, with soft wet material at its bottom. This was at an elevation about 200 ft. above tunnel subgrade.

COMPRESSED-AIR METHODS.

During the early part of February, an O'Rourke air lock which had been used on the North River tunnels in New York was brought to the site and installed in the heading, its end being set in a 4-ft. concrete bulkhead wall about 40 ft. in front of the point where the roof had broken through. This lock was 7 ft. in diameter and 25 ft. long, equipped with a material track and small steel material cars. Air pressure was put on the heading on Feb. 23 and work was resumed at the face, which was then 10 ft. behind its position when the first break occurred. A pressure of 20 to 35 lb. per square inch was found to be necessary, and an average of about 25 lb. per square inch has been maintained throughout the work.

A new tunnel section, enlarged to provide space for a concrete lining and invert, was adopted for the soft ground. This section, together with the timbering used in its construction, is shown in Fig. 1. The width of excavation for this section, upon resumption of work within the lock, was made 21 ft. between wall plates.

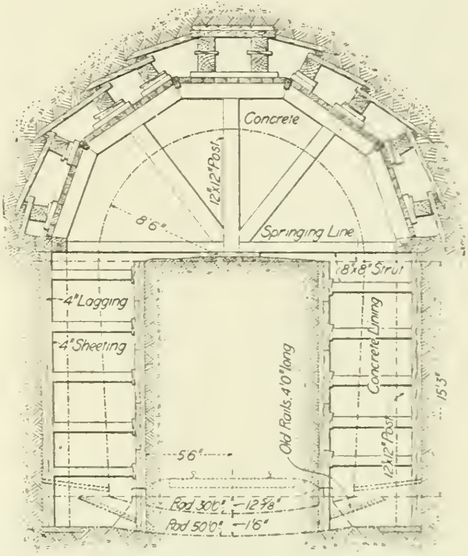


FIG. 1.

In proceeding with the excavation within the lock, a small crown drift was driven ahead as before and enlarged toward both sides by driving poling boards outward and working down with temporary radial timbering. The vertical posts in the sides of the drift were 12x12-in. timbers, 2 ft. on centers, so in widening toward the sides, excavation was made between the posts and the first set of temporary 12x12-in. radial struts placed in the space thus gained. The posts were then removed while the struts took the roof load, and then a second set of struts was placed in a similar manner. This was continued down far enough to permit placing one angle segment of permanent timber, and similar drifts were driven along the line and grade of the wall plates for setting the two lower angle segments and the wall plates. The segments consisted of 12x12-in. oak arch blocks, 2 ft. on centers with 4x8-in. oak lagging. Radial struts were provided to hold the blocks in place as the core was removed. All space behind the permanent timber was packed tightly and grout was forced in through pipes in the arch blocks by means of a compressed-air jet.

PLACING THE SIDE WALLS.

As the work progressed, the dip of the rock toward the east caused the hard rock floor of the heading to run out about 15 ft. beyond the first break, so that provision had to be made for the construction of the side walls below the wall-plate elevation to a footing on the solid rock. The method followed was to sink sheeted pits downward from the bench level along the lines of the wall plates, these pits being worked back to the outside line of the excavation so as to permit the vertical side posts to be placed within them. The location of these pits and the plan of timbering them are shown in Fig. 2. The general procedure was to work them in 8x8-ft. sections, a set of 16-ft. timbering braced in the middle serving to form two such pockets. Tight 4-in. sheeting was used in sinking these pockets, the row next to the wall plates being driven on a batter so as to bring it eventually behind the lines of timbering. Pits of this size were as large as the material would permit, and in some cases the dimensions had to be reduced to even less than 8x8 ft. Considerable difficulty was experienced in gaining headway against the soft material in the bottom, and if the pressure was released, it would boil up rapidly.

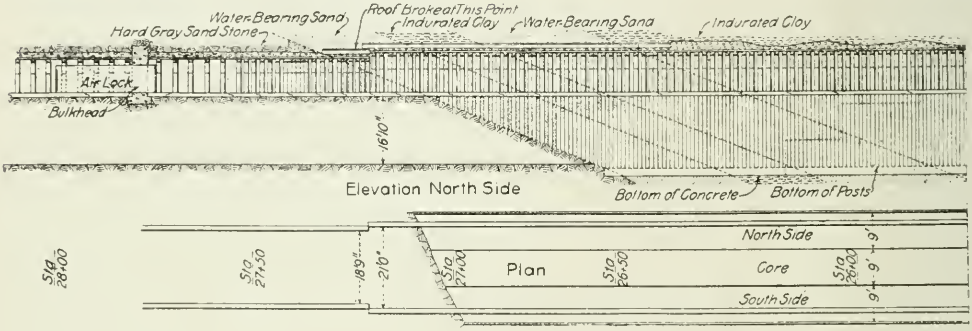


FIG. 2.

As soon as a short section of trench had been opened along one of the side walls, vertical 12x12-in. side posts were set under the wall plates, 2 ft. apart on centers, and the spaces between posts filled with a solid 12-in. wall of 1:3:6 concrete. This work was all behind the back lines of the finished tunnel side wall. When a section had been made tight on both sides in this manner, the tunnel core was removed as far down as the solid rock floor.

With the further advance of the working face, the floor continued to dip away and the depth of the pits and the length of the side-wall posts continued to increase correspondingly until, at a point about 40 ft. beyond the start of the soft material, the rock dipped entirely out of the bottom, placing the whole tunnel section in soft material. It then became necessary to place wall footings in the bottoms of the side trenches and to provide for the concrete invert. This involved the sinking of the pits to a level about 2 ft. below subgrade and placing a 2-ft. concrete footing about 6 ft. wide in sections 8 ft. in length, the walls being built as before. Concrete for all of the work within the lock was mixed by hand on a board inside.

DRAINAGE AND SPOIL HANDLING.

Drainage of the wet heading during these operations was effected by drawing the water to sumps in the ends of the side trenches and ejecting it by an air jet through a 4-in. pipe. equipped with a 3-in. wire-reinforced suction hose. A large amount of the soft material was also removed through this pipe with the water. The pipe discharged into a sump on top of the bench outside of the lock, where a force-pump threw the water to the outside drain and laborers shoveled the sediment into spoil cars. The gritty character of the material passing through the pipe caused very rapid wear, some of the valves and fittings lasting only a couple of days.

Outside of the air lock, material tracks ran along the top of the rock bench and then, at the point where work had been started by the steam shovel on the removal of the bench, a timber gallery was built at the springing line of the arch. The spoil cars ran along this gallery to a chute from which they dumped into 1½-yd. cars on the steam-shovel track below. An incline at the end of the gallery served to bring up the cement and other lock materials.

The labor problem for compressed-air work at this point in the mountains was a source of some difficulty. About 75 men for this class of work were required practically continuously, there being three shifts of about 25 men each. Most of the labor familiar with this class of work is found around the large cities, and the air men or "sand hogs" engaged on this work came mostly from New York. About three-quarters of these were negroes. The nearest Southern States also supplied a few. During the times when the pressure was high, the working shifts were reduced to two 3-hour periods, with a 3-hour rest period in between.

POWER PLANT CHANGES.

A considerable addition to the power plant equipment was necessitated by the introduction of compressed-air methods. Originally there were two Class AA2 Ingersoll-Rand compressors, each giving 1250 cu. ft. of free air per minute. These were driven by three 100-hp. Brownell boilers. An additional compressor of the same type was installed, with capacity of 1650 cu. ft. of free air per minute, and two 125-hp. Pennsylvania boilers were added to the steam plant. This plant compressed the air to 110 lb. per square inch for all tunnel service, and that for the use in the lock was reduced to the required low pressure by a Westinghouse automatic reducer valve.

At the time these notes were made, hard rock had been reached again in the top of the heading and the inclination of the rock indicated that the entire section would again run into firm material. This is at a point about 195 ft. from that where the soft material first ran in. About 250 ft. still intervened between the west and the east headings. The latter has progressed favorably in hard rock of a character similar to that first encountered in the west heading.

On Oct. 25 the concrete lining was completed in all of the soft-ground section which was water-bearing, and from all indications it seemed safe to release the air and go ahead with ordinary soft-ground methods. This was done four days later, and for several hours there were no signs of undue pressure or of water breaking in, but in the evening of that day, the bottom of the tunnel bulged up ahead of the concrete invert and water came through in large quantities. Accordingly pressure was again applied so that a further advance of 50 or 60 ft. could be made before finally releasing the pressure.

Geological conditions somewhat similar to those in the tunnel have been found in a large cut about 1 mile farther west. This cut is 2400 ft. long, 90 ft. deep and contains about 250,000 cu. yd. It is at the summit point of the main Allegheny Mountain ridge, of which the ridge pierced by the tunnel is a spur. Wide seams of soft material between hard layers of rock were encountered in this cut and a large amount of water was present.

The Big Savage tunnel is being built for the Western Maryland Railway under the direction of Mr. H. R. Pratt, chief engineer, and Mr. G. H. Friend, principal assistant engineer. The Carter Construction Company, of New York, is the contractor. Mr. A. W. Jones, chief engineer of that company, is in charge of the work at Big Savage. Details of the compressed-air working methods were developed under his directions by Mr. E. E. Evans, superintendent at the tunnel.—*Engineering Record.*

MINES IN TWO STATES—OR IN NEITHER

Robert Richards, State Mine Inspector of Missouri, says that at Coal City, Mo., the entrance to the mine is in Missouri and the two cagers at the shaft bottom are in Missouri, but the main entry runs immediately into Iowa, and every other man working in the mine is working in Iowa. Consequently it was a question with him whether he had a right to inspect the workings of this mine and report to the Missouri authorities. At Leavenworth, Kan., another similar though opposite condition exists. The miners are all working under ground that is in Missouri, but the entrance to the mine is in Kansas and the cagers at the bottom are working in Kansas. In order to inspect this mine he had to go into the state of Kansas and come back into Missouri after reaching the bottom. He has asked advice as to whether one or both of these mines is in the state of Missouri—whether the Coal City mine is in Missouri or Iowa, and whether the Leavenworth mine is in Missouri or Kansas. If the Coal City mine is in Missouri and not in Iowa, then he thinks the Leavenworth mine is in Kansas and not in Missouri, since the conditions are reversed at the two mines. He is willing to inspect both of them, or either one, according as he finds his jurisdiction to embrace one or the other or both, but he is from Missouri and wants to be shown, so that he will make no mistake. He is required to inspect all mines in Missouri, but cannot legally inspect mines in another state—if either of them is to be considered as being in another state.

A TURBO DRIVEN CENTRIFUGAL BLOWER

We have the report of a test recently made of a centrifugal blower direct connected to a steam turbine, the test having been conducted with care and thoroughness as its purpose was to determine the fulfillment of certain guarantees given by the builders. The test was specially interesting from the fact that the air delivery pressure was about double that which has usually been considered the limit.

The blower set tested consisted of a double inlet Sturtevant multivane centrifugal blower mounted on the same bed with a Terry steam turbine and direct connected. It was to deliver 40,000 cubic feet of air per minute against a pressure of 40 inches of water, the test being to determine the water rate of the turbine and the closeness of the speed regulation as well as the volume and pressure of the air.

During the test, pressure, temperature and calorimeter measurements were made of the steam just in front of the governor valve, and the exhaust pressure was measured in the exhaust pipe just beyond the outlet of the turbine. The exhaust steam was taken to a surface condenser and the discharge water from the hot well was weighed. The condenser was vented at the top so that it would not produce vacuum at the exhaust of the turbine, which was run non-condensing.

To measure the volume of air discharged by the blower, a long tapered cone having a coefficient of discharge of 0.94 was attached to the outlet, the pressures being taken with a mercury U tube. The blower, rated to deliver 14,000 cu. ft. of air a minute, averaged 15,169 cu. ft. for nearly an hour. Steam required for the turbine was not to exceed 7,600 lb. an hour, but during this test steam was used at the rate of 6,587 lb. an hour, or 13.35 per cent. less than the guaranteed maximum.

Air pressure maintained was to be 40 in. of water, but for nearly an hour this blower averaged 47.3 in or over 1½ lb. per sq. in. It reached a maximum during a portion of the test of 51.7 in. Considering the excess in both volume of air and the pressure at which it was discharged, the blower set delivered 27.5 per cent. more work than was called for. Reducing the guaranteed conditions to steam consumption per air horsepower gave a result of 58.5 lb. as against the guarantee of 86.13 lb.

In the various tests the pressure at the nozzle inlets of the steam turbine varied from 100 to 106 lb. and the speed from 24.45 to 24.80 r.p.m. The velocity pressure varied from 46.2 to 51.7 in. of water, and the volume of air delivered from 15,000 to to 16,000 cu. ft. per minute, the air horsepower from 109.1 to 129. Average values for the test were: Steam pressure at the throttle, 145 lb. per sq. in., at the nozzle inlets, 102.5; pounds of steam used per hour, 65.87; speed, 2463 r.p.m.; velocity pressure, 47.3 in. of water; velocity of air at the outlet, 26,900 ft. per minute; volume of air delivered, 15,169 cu. ft. per minute. Actual air horsepower, 112.6.

A separate test to determine the speed variation gave the following results: The turbine was operated at 2,490 r.p.m. without load; with full load thrown on momentarily the speed was 2,400 r. p. m., and with the full load soon settled to 2,460 r.p.m. This shows that the momentary speed drop was 3.6 per cent. in the settled drop only 1.2 per cent. While the blower was running under full load at 2,460 r.p.m. the gate was closed suddenly the speed momentarily jumped to 2,575 r.p.m. or 4.7 per cent., but it quickly settled to 2,490 r.p.m., or an increase of 1.22 per cent. over that at full load.

WATER JETS IN ROCK DRILLING

Mr. C. J. N. Jordan, in the Journal of the South African Institute of Engineers, describes a method of dust prevention in rock drilling by forcing a jet of water at high pressure into the hole all the time the drill is working, showing at the same time a great increase in drill efficiency or an important saving of time and power.

The requirements of the water jet system are a line of pipes 1 in. or more in diameter, supplying water to within a safe distance of the face, where they cannot be damaged by blasting operations. To this is attached an armored garden hose of ½ in. or ¾ in. diameter. The hose is removed during blasting operations, but it is absolutely essential that it should reach easily up to the very face of the drive to insure proper working conditions for the system and also that there should be a head of water of 40 to 80 lbs. per square inch. From the very first stroke of the drill a back or dry hole gives dust; it is thus essential that so soon as the drilling operation starts a jet should be played on to the face where the drill starts to collar. As the hole deepens, the hose, which has been previously slightly flattened, is inserted into the hole by the helper. The object of flattening the hose is dual—it assists in the formation of a more or less forcible jet and it does not interfere with the action of the drill, as it takes up less space in the hole.

It stands to reason then that this jet of water playing constantly to the very back of the hole kills the dust where it is made. It is found possible at any moment during the process of drilling to stop the machine and water at the same instant, and to detect that no dust and hardly any grit is present in the hole. The dust then is never formed. As the hole is deepened the hose may be inserted further, until it is about 18 ins. or 2 ft. in at the time the hole is finished. An examination of a finished 5 or 6 ft. back hole will show a clean barrel, free from obstruction of any sort. Once a hole is commenced with this method the water supply must not be interrupted, for the dust and grit would cake with the small amount of water left in the hole on stopping and jam the drill.

It may be thought that great inconvenience would be caused to the machine workers, or at any rate to the helper holding the hose in position, for one naturally thinks that a drill pounding away into a hole almost filled with water would cause spray and sludge to spurt all over the place. In practice this is not the case. The helper standing at the face all the time a hole is being put in will be found to be almost free from damp on his clothes, and as a matter of fact the water flows quietly out of the hole down the face carrying in suspension all the disintegrated rock, whether in the shape of dust or grit. The tendency of the drill to fitcher is minimized by this system, for the hole is kept so free from grit and the drilling is more rapid than under the ordinary system.

This method has to its credit advantages of economy, small in themselves, but nevertheless saving in time and money. We know that in practice it takes a miner anywhere from 2 hours and upwards to put in a back hole under present conditions. With the jet playing into the hole it is possible to put in a 5 to 6 ft. hole in about 1 hour and 20 to 30 minutes in hard quartzite.

The only practical objection to this method is the quantity of water used and the consequent flooding of the drive. The failure of similar ideas elsewhere has been due, probably to the small volume of water used. If, however, a drain is cut and kept open the water can be led away. The extra cost of pumping is inappreciable.

Below are given tables showing the records of two experiments in which it may be seen that considerable saving in time and in drill steel was made over the ordinary way of drilling a dry hole.

Holes 1 and 2 were 8 ins. apart and were drilled dry and wet respectively in hard quartzite, and in the same bed of quartzite. The same angle of elevation was kept by dropping the arm about 8ins. after the No. 1 hole was drilled. The same machine and men drilled both holes. The air pressure remained constant, 60 to 65 lbs. The collaring in each hole was good. The time given does not include time for changing bits, but only actual drilling time.

HOLE NO. 1—DRY.

	Minutes.	Depth, ins.	Bit marked
Collaring	4	0	A
Starter No. 2	10	5	B
Starter No. 3	27	7	C
Second cross bt	15	5½	D
Second chisel bit	10	6½	E
Second chisel bit	27	7	F
Total	93	31	

HOLE NO. 2—WET.

	Minutes.	Depth, ins.	Bit marked
Starter No. 1 collared and drilled	9	11	G
Second chisel	7½	13	H
Third chisel	12	9½	J
Fourth chisel	14	25½	K
Total	42½	59	

HOLE NO. 3—DRY.

	Minutes.	Depth, ins.	Bit marked
Collared and started hole	50	17	L
Second starter	25	6	M
Second cross-bit	28	7	N
Fourth chisel	18	7	O
Fifth chisel	29	11	P
Total	150	48	

HOLE NO. 4—WET.

	Minutes.	Depth, ins.	Bit marked
Collar and starter	32	22	Q
Second diamond	41	28	R
Third chisel	14	18	S
Total	87	68	

The totals show 93 minutes to drill 31 ins., or .33 in. per minute, as compared with 42½ minutes to drill 59 ins., or 1.34 ins. per minute, by the method described. Furthermore the drills G, H, and J did 33½ ins., in 28½ minutes, as compared with 31 ins. in 93 minutes with 6 drills by the ordinary method. Holes 3 and 4 were drilled with two different machines in very hard quartzite cross cutting the formation. The two holes were in identical rock. The dry hole was steeper than the wet one.

Thus by the wet method 68 ins. were drilled in 87 minutes, or .78 in. per minute, as compared with 48 ins. in 150 minutes, or .33 in. per minute, by the dry method. The two drills Q and R drilled 50 ins. in 73 minutes, as compared with 48 ins. in 150 minutes with five drills. It will be seen therefore that there is a saving of from 30 to 50 per cent. in drills and that no more time is required for the drilling of a back hole than a wet or down hole.

VACUUM PPARATUS FOR CASTING METALS

BY E. F. LAKE.

While casting metals *in vacuo* is an old principle, it has not been developed to any extent until quite recently. Occluded gases and those segregated in large enough volumes to form miniature bubbles or the larger blowholes, are only beginning to be recognized as the real injurious elements in metals of all kinds. The oxygen, nitrogen and other elements that form these gases, enter into combination with the elements that are parts of the various alloys from which castings are made and form oxides, nitrides, etc., and thus detrimentally affect the strength, wearing qualities and other properties that it is desirous to obtain. By melting metals, or casting them in a vacuum, these gases can be almost entirely removed and the mechanical properties of metals or alloys greatly improved. This principle is fast growing in favor and therefore, it may not be very long before casting in a vacuum will be quite common.

Some metals are very brittle, and when worked by ordinary methods cannot be rolled and drawn. When melted in a vacuum, however, they have been drawn into wire for various purposes. Examples of such metals are tungsten and tantalum, which are made into wire for incandescent lamps. Another metal very difficult to melt in the open air is magnesium, and this has been readily melted in a vacuum furnace. This is accomplished by building an air-tight chamber around the melting pot or furnace and pumping out all of the air. An electric current then generates the heat necessary for melting the metal and no oxidation can take place, as the oxygen has been removed, likewise, the nitrides, sulphides, phosphides, etc., do not form and the metal has a more dense, homogeneous grain than can be given it by any other process.

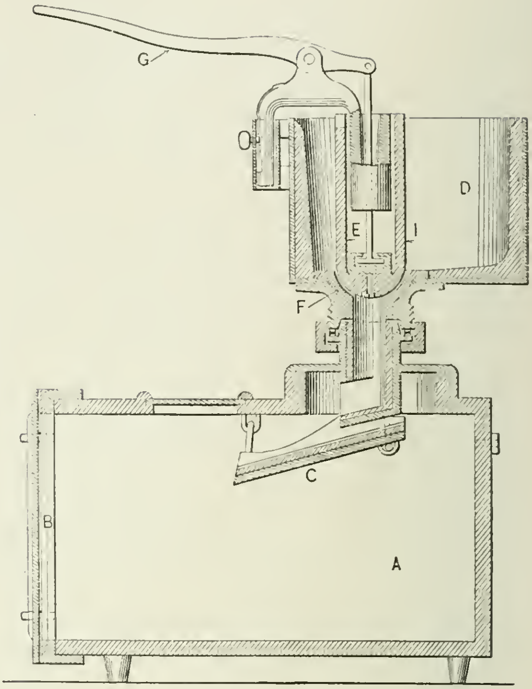


FIG. 1.

Even though the principle of casting *in vacuo* is very old in this country, the first recorded invention of apparatus for this purpose was that patented by H. V. Barnum, in 1879, as shown in Fig. 1. Here, A is the vacuum chamber, and B a door through which any kind of a mold can be inserted. This door covers the whole end of the vacuum chamber. A clay-lined pot, D, of molten metal is fastened to the top of the vacuum chamber in such a way that no air will be admitted and when the mold is ready to pour, valve E, which is made of some refractory material, is raised by lever G out of valve seat F, and this allows the molten metal to flow from pot D through spout C and into the mold. Spout C is made fan-shaped so the vacuum may cause the es-

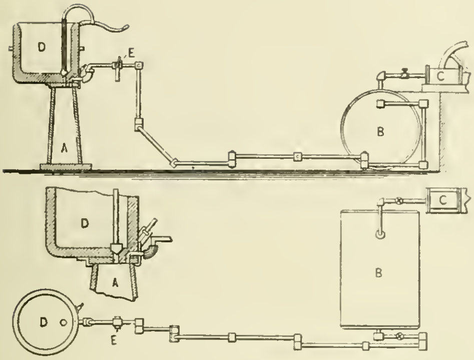


FIG. 2.

cape of most of the gases out of the molten metal as it flows over the surface.

CASTING STEEL INGOTS IN A VACUUM.

In Fig. 2 is shown an American device for casting ingots *in vacuo.* In this the ingot mold and ladle are constructed in such a way that when the ladle of molten metal is placed on top of the ingot mold, it seals it air-tight. To remove the air from ingot mold A, a tank much larger than the mold is located at B and vacuum pump C brings about a vacuum in tank B. Ingot mold A is connected by piping to tank B and when the ladle of molten metal D is lowered to the top of the ingot, ready to pour, valve E is turned on and into tank B is exhausted the air in the interior of ingot mold A. The vacuum pump is kept working all the time the ingot mold is being filled. Thus, while the molten metal is falling into the mold and flowing around to different parts, the gases are carried away. With this arrangement a universal joint makes it easy to connect to each ingot mold in a short time, and thus very little time is lost.

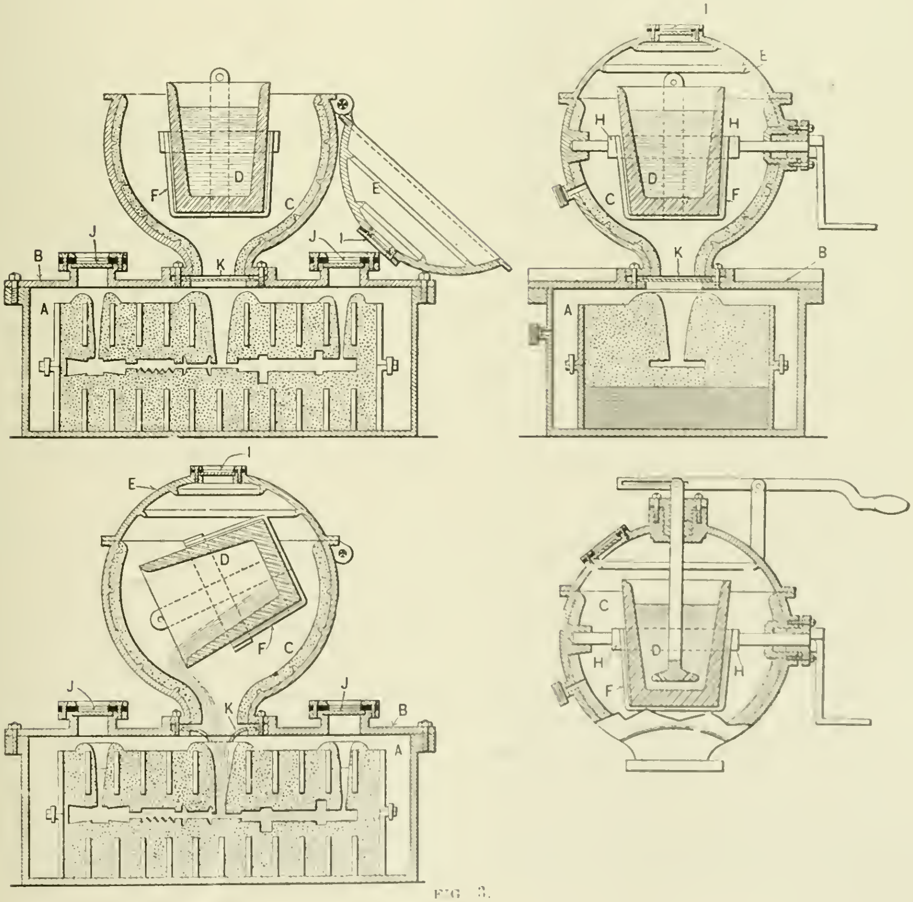


FIG 3.

CASTING SAND MOLDS IN A VACUUM.

Another apparatus for casting sand molds *in vacuo* was brought out in 1893; its construction and method of operating is shown in Fig. 3. In this, A is the vacuum chamber; B, the top which lifts off to admit the mold; C, the ladle container, which is also a vacuum chamber, and D, the ladle. To operate it, cover E is swung back, as shown in the upper left hand view, while the ladle of molten metal is lowered into its holder F. The cover E is then swung over the top and it fits air-tight, as shown in the other views. When the air has been exhausted from chambers A and C, ladle D is turned over in its trunnions H H, and pours the molten metal into the mold. In the ladle cover at I and in the top of the mold chamber at J J, are located glass plates so that the operator can see how the ladle is working and when the mold is filled.

While exhausting the air from vacuum chambers A and C, the gases and vapors rising from the molten metal are carried away and this renders the metal dead by removing all tendencies toward ebullition. By removing the gases from the metal, a more dense and fine grain is given the castings and as the molecules that form the mass are not separated by these gases they are held together with a great cohesive force.

If desired, an attachment can be easily put on cover E by which the metal in mold may be stirred by a disk, located on the end of a bar passing through the center of the cover and attached to a lever on the outside. Such an arrangement is shown in the lower right hand view of Fig. 3. It would hasten the pouring, as the ladle is turned over as soon as the gases cease to rise from the molten metal. Stirring would bring all parts of the molten metal subject to the vacuum condition, and thus quicken the escape of the gases. To facilitate this, a fusible plate is located at K to separate the ladle chamber from the mold chamber. Thus, the air can be exhausted from each separately and the gases drawn away from the ladle without interfering with the mold. As soon as the molten metal strikes this plate it melts and allows the metal to flow through, as shown in the lower left hand view.

APPLICATION OF VACUUM TO DIE CASTING.

The most successful and largest application of the principle of casting in vacuum is in connection with die-casting. As permanent molds that are made of metal are used to give the castings their shape, a vacuum can be established in their cavity without using a vacuum chamber, or the die-mold can be located inside of a vacuum chamber without specially constructing the mold, fear of injuring it, or altering its ability to make perfect casting. They can be made to operate automatically either inside or outside of a vacuum chamber and very little additional apparatus is required on the die-casting machines. The vacuum overcomes faults that it is very difficult to get rid of in any other way when squirting molten metal into metal molds under pressure.

To establish a condition of vacuum when manufacturing die-castings, several forms of machines attach piping directly to the casting cavity in the die-molds and connect this piping to an air pump. This removes the air from the mold just before squirting in the molten metal. This insures that every corner and crevice in the die-mold is completely filled with molten metal and good sharp castings with perfect exteriors are obtained.

A die-casting machine that uses this principle is shown in Fig. 4. In the upper view, die-mold A, which is in three parts, is connected by flexible hose B to air-pump C. In this position, the die mold is ready to receive the molten metal that forms the casting. In the lower view, the mold is shown as it is opened for the ejection of the casting. As will be seen, the outer half of the mold is located on a carriage that rocks away from the inner half of the mold; while the upper part of the inner half is raised away from the lower part. This machine is driven by pulley and belt and all of its movements are performed automatically by the aid of gears and cams. All the attendant has to do, therefore, is to keep the melting pot filled and carry away the castings.

While the extraction of the air from the die-mold, as shown in Fig. 4, has many good features, it is not possible to extract any of the gases that may be contained in the molten metal. In order to obtain a more complete vacuum, therefore, a die-casting machine like the vertical one shown in Fig. 5, was designed and this is in daily use. Here, a comparatively large vacuum chamber, A, forms the body of the machine and the melting pot D, with its gas-heating furnace C, is located over

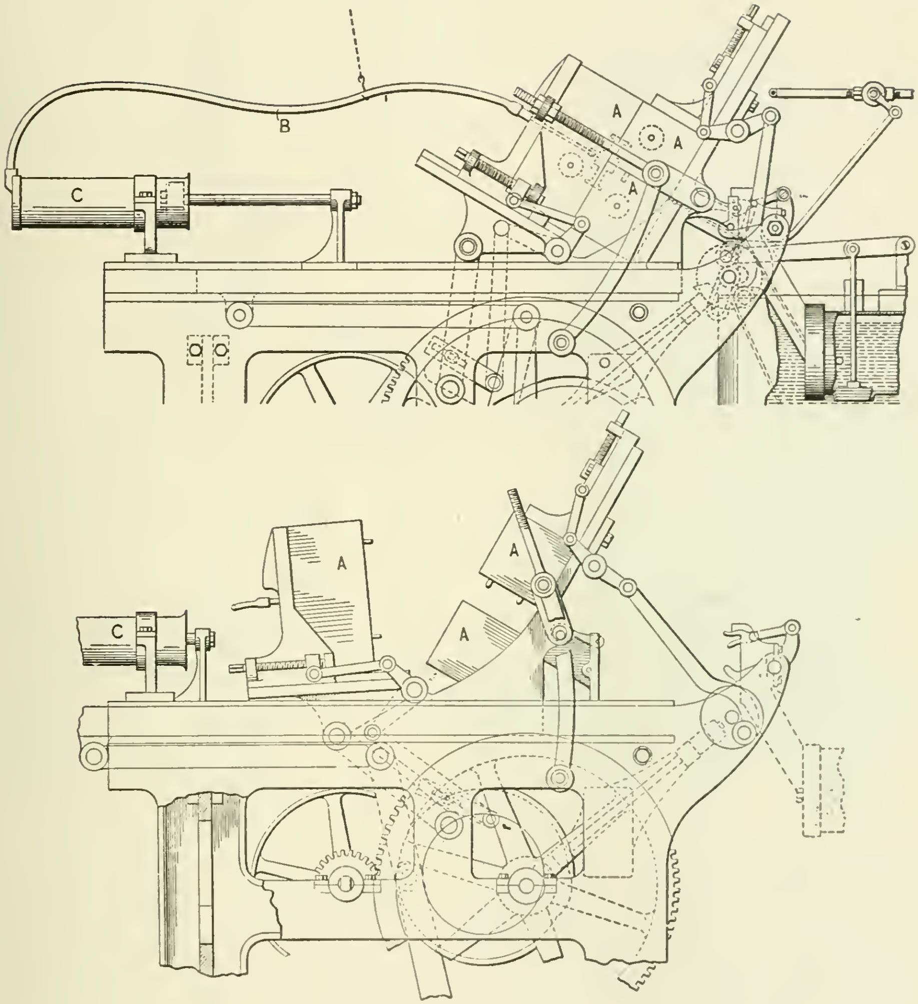


FIG. 4.

it in a very similar manner to that of the sand mold casting apparatus shown in Fig 1. In this case the driving shaft B, with its pulley R, and the cams that control the movements of the machine, are located in the base, below the vacuum chamber.

The die-mold E is located just below the melting pot and inside vacuum chamber A. To make such a machine successful, therefore, the mold must be opened and closed; the molten metal squirted in, and the casting ejected from the mold automatically, and that is the manner in which this machine operates. The mold opening and closing automatically, inside of this vacuum chamber, no air is allowed to collect in the casting cavity, even when the mold is opened to eject the casting. Any gases that may be in the metal when entering the die-mold, are inclined to be drawn through the vent openings of the mold and out into the vacuum chamber. A more complete vacuum can thus be obtained than with the principle shown in Fig. 4.

By placing the die-mold inside a vacuum chamber, as in Fig. 5, these troubles are overcome as a continuous vacuum can be maintained in this chamber. By milling out sections, one or two thousandths of an inch deep, on the parting surfaces of the mold, the mold will be vented, so a continuous vacuum can

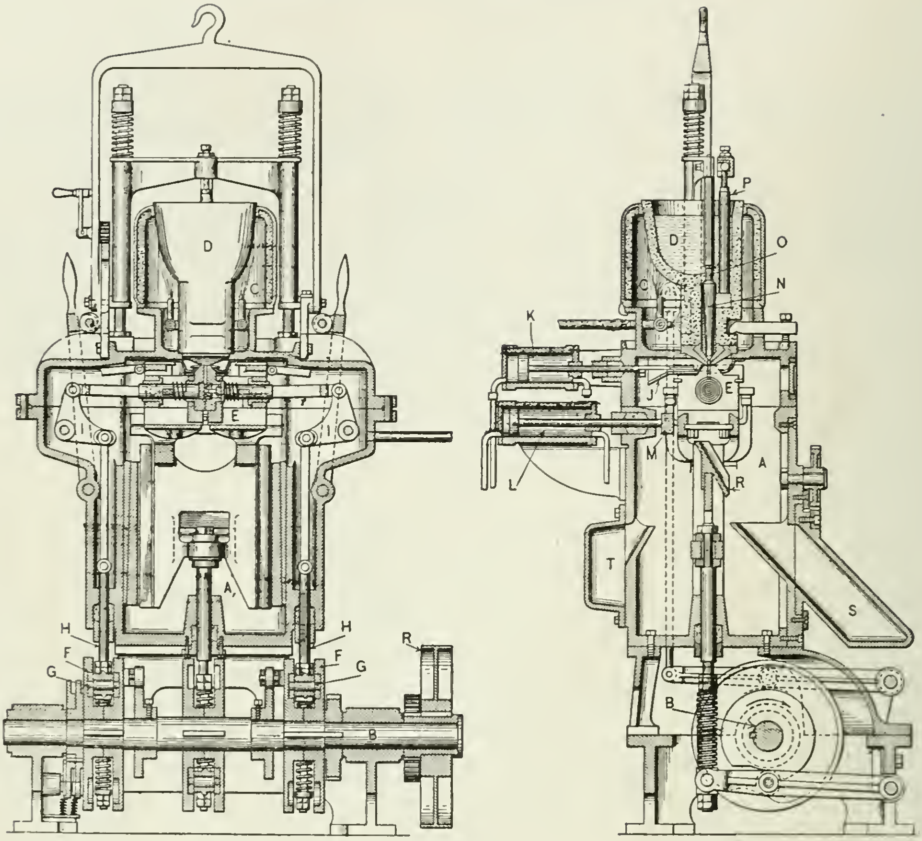


FIG. 5.

be maintained in its casting cavity. The mold is then easily parted and these vent openings are not large enough to fill with metal and form fins on the castings. In addition to causing the metal to be drawn into all crevices of the mold the molten metal is forced into the mold with from 80 to 100 lb. per square inch pressure. This tends still further to refine the grain of the castings.

In the left hand view of Fig. 5, the mold is shown closed; but when the double cams F turn over, rollers G on rods H operate levers I and thus pull the halves of the die-mold apart. As there is always a tendency of molten metal dripping when the die-mold is pulled away, or parted, a drip deflector J is immediately pushed under the nozzle and causes any drippings to fall into pocket T. This prevents molten metal from spoiling the finished castings. A second air cylinder L moves Brush M over to brush out the casting cavity in the die-mold. To force the metal into the mold when it is closed, valve N is pulled away from its seat in the nozzle opening and this closes another seat above it at O, where the metal enters the passage from the melting pot. When opening O is closed, plunger P is forced down and this squirts the metal, contained in the passage, into the die-mold.

All of these motions are timed so that the various operations will follow each other continuously and produce castings without any manual labor except that of filling the melting pot. They are turned out by this vacuum machine much faster than they can be made by any hand-operated machine. In fact, as fast as the metal will solidify in the mold, the casting is thrown out and the mold closed for another without any lost time. As the mold is opened and the castings are ejected, they fall into deflector spout R, which throws them into pocket S, and they are then easily taken away from the machine. This is doubtless the most perfect manner in which castings of any kind are made, and it shows the height of the development of the die-casting process and the perfection that has been reached in casting methods.

A horizontal machine of this same type, fastens one half of the die-mold to the nozzle and locates the other half on a carriage that slides back and forth. Thus, the back half is drawn away from the forward half to eject the casting, the vacuum is established by two tanks, in which a continuous vacuum is maintained, located on each side of the mold. When the half mold moves to the closed position, connections are made to these vacuum tanks and the air is sucked out of the cavity of the die-mold. The exact form of the machine is immaterial as long as the vacuum is successfully created in the casting machine.

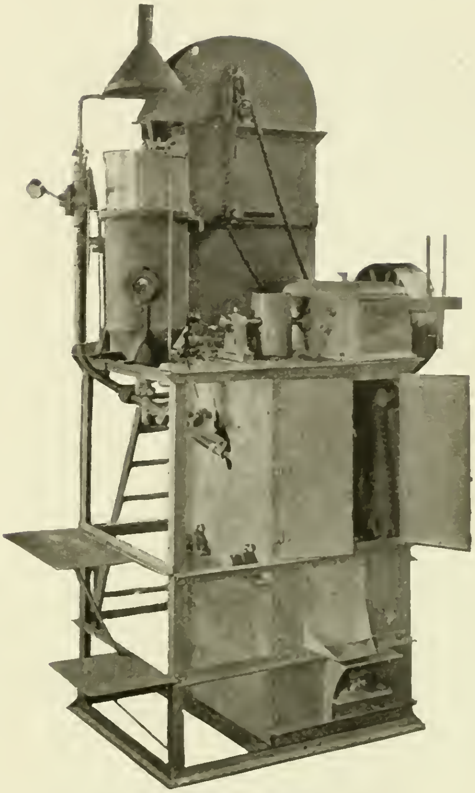
The thing that has made it possible to manufacture die-castings of the strength of yellow brass is the application of the vacuum principle to die-casting machines. To construct a die-casting machine and molds that will stand a high enough pressure on the incoming metals to make dense, sound and strong castings would be very expensive, but by adapting the vacuum principle to these machines, this has been accomplished at a cost that is not prohibitive.

All kinds of castings are made so much better by casting them *in vacuo,* as well as by melting the metals in a vacuum, that this principle is bound to increase in commercial use and doubtless vacuum castings will become more commonly made and used in the future. Improvements will probably be made in the methods of casting sand molds in a vacuum that will make these cheap enough to be a commercial success, and where any kind of a permanent mold can be used, castings for machine parts or for various kinds of apparatus and instruments can be profitably made in a vacuum.—Abstract from *Iron Age.*

A SELF-CONTAINED SAND-BLAST TUMBLING MACHINE

The half-tone shows a combined sand blasting and tumbling apparatus brought out by the London Emery Works Company, of Park, Tottenham, London, N.

The outer case of the machine encloses a perforated tumbling barrel rotating on rollers. On the inside of the barrel a number of pieces of angle iron are fixed which throw the castings in different directions and thus prevent any of them from simply slipping around the inside and escaping the sand blasting. As the barrel turns quite slowly not much tumbling effect is apparently expected. According to the size of the barrel, blast nozzles are placed in an inclined direction and are given a swinging movement so that they thoroughly blast the entire contents. The opening provided in the barrel for charging the castings is also used for changing the chilled iron nozzles which are held in position by a union.



SAND BLAST TUMBLING MACHINE.

Under the barrel an inclined perforated plate is fixed on to which the castings fall as discharged. Beneath the plate is a spiral conveyor which carries the used sand to a bucket elevator. The driving arrangements for the barrel and the nozzles are on the top of the outer casings in a closed cast iron box. The largest size of this apparatus is fitted with two conveyors and double elevators to deliver the sand into the two-pressure sand blast apparatus placed on each side of the barrel. The sand or shot falling out of the barrel with the castings drops through the perforations of the slide. While the barrel is being discharged and reloaded the two-pressure sand blast apparatus is refilled with sand or shot. What is not reduced to dust falls through the perforations of the barrel and the outlet shoot into the spiral conveyor and thence by the elevator it is returned to the two-pressure sand blast apparatus, while that which is reduced to dust is carried away by an exhaust fan.

Previous designs of apparatus of this type have had the disadvantage of great wear of the piping between the sand blast apparatus and the tumbling barrel, and there has been an inefficiency of the sand stream on account of the many alterations of direction by the various sharp bends traversed before reaching the nozzles.

By attaching the sand blast apparatus to the side of the outer casing this machine is made self-contained, which not only saves the intermediate rubber hose but also reduces the floor space. This construction also allows all the valves to be conveniently placed, and there is less time lost in filling, starting and stopping, and cleaning the valves should they become choked.

VISIONARY TAYLORISM

The following occurs in the London *Engineer's* review of the new book, *Power,* by Dr. Chas. E. Lucke, lately noticed in our columns:

But having discussed the forces causing unrest in the labour world he propounds his remedy. It is somewhat of an anti-climax to find that this remedy is an application of some form of profit sharing, and of what has come to be called "motion-study." The first of these remedies whether of the nature of real profit sharing or of the premium bonus type, has already been proved of no avail, and even a source of further discord. The second, popularly known as "Taylorism," is just beginning to rear its head in America. We have already expressed our opinion on this inhuman method of speeding up and reducing labour wastage, and need only add one word to what we have already said against the system. It is undoubted that there is an enormous waste of labour every day in our workshops, and that if this labour were usefully applied the cost of production might be greatly lessened, and wages consequently greatly increased. But Mr. Taylor and Dr. Lucke, and all others looking with covetous eyes at the labourer's idle movements, must know that no machine, however perfect mechanically, can possibly convert into work all the energy supplied to it. A large part is wasted, and must be wasted, in accordance with natural law. Can the advocates of Taylorism or any one else expect the human machine to be more perfect?

BILL AND THE SUPE

Now listen to me, while I tells to you,
The tale of the Supe an' Bill McGrue.

Bill he was takin' a little mope
After drillin' his holes in the stuffy stope.

An' settin' down on a timber car
He lights a match to a bum cigar.

He scurcely more than gits a light
When a guy in overalls heaves in sight.

"Takin' a rest?" says he to Bill.
"You bet," says William, an' sets right still.

"Ain't you got nothin' at all to do?"
"I have," says Bill, "when I'm ready to."

"What would you do," says the stranger guy,
"If the shift boss happened to wander by?"

"I'd set," says Bill, "like a tired bloke,
An' take my time fer my rest an' smoke."

"Do you know," says the stranger, "who I am?"
"I don't," says William, "nor care a damn!"

"Well, I am the Superintendent here!"
Bill's grin extended from ear to ear.

"The Supe," he says, "of the hull big mine?
That's bully," he says, "that's grand, that's fine;

A mighty good job fer a man to git,
If I was you I would tend to it!"

Then Bill leans back on the empty car
An' goes on smokin' his bum cigar.

Berton Braley in *N. Y. Times.*

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MAGAZINE

EVERYTHING PNEUMATIC

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AIR ENGINEERING.

Why have we not air engineers as well as electric engineers and the others? Compressed air and the air compressor would seem to be sure of constant and of continually extending employment, as long as industry and civilization continue. The conditions of air employment already have almost unlimited range. Air is required, according to the uses to which it is to be put, at all pressures, from that which is measured by tenths of an inch of water, up to thousands of pounds to the square inch; and in all quantities or volumes from that sufficient to spray perfumery upon a lady's handkerchief up to the blowing of a blast furnace.

The requirements in air compressing apparatus have, by a large industrial automatism, differentiated or separated themselves until now we have immense manufacturing establishments devoted each exclusively to one of at least four different and distinct classes of air compressing apparatus. There are manufacturers of fan blowers, of "pressure" blowers, of blowing engines, and of air compressors distinctively so called, each producing its specialty exclusively.

By far the most numerous and, as would seem, the most important of these several apparatus, is the air compressor, whatever the drive of it may be, which has air compressing cylinders with reciprocating pistons, so that compressors of this type must apparently, for a long time to come, have the first place in our considerations of efficiency and of applicability to the different requirements which are developed.

Although the operating of a water pump and of an air compressor may, at first thought, seem quite similar, the conditions and requirements really are different all the way through, and the problem of the latter is vastly more complex and difficult. The elasticity alone of the air changes the character of the work at the beginning of it, and the resulting transfers or transformations of opposing pressures are only a small part of it. Questions of temperature, of humidity, of velocities of flow, each furnish their factors, and then the matter of storage and of adjusting the air output to the consumption demand to be provided for.

It is no longer sufficient in any line of manufacture to produce a machine which will actually work and which can be guaranteed to keep on working, although these are essential requirements. The precise manner and measure of its working in addition to that may determine its acceptance or rejection. The working must be as economical of power as possible, or must best satisfy certain other conditions of service which are often quite imperative. The fewer the sacrifices of essentials involved and the more satisfying the unavoidable complications, the more desirable the apparatus.

In the variety of air compressors required, both as to size or actual capacity and also as to the relative capacities of the power-developing and the power-applying elements, it must be evident that the works of large capacity has a great advantage, and one which it may legitimately claim for itself.

Not only is the most satisfactory air compressor to be expectantly sought in the older and larger establishments, but here also should be found the larger experience, and, as a consequence, the most competent advice as to air employment. One cannot be a qualified designer and builder of an air compressor, or of anything else, without following it out into the field of its employment to see how it does its work and how its working might be improved, or, in some cases, how changes in the methods of using the air might be made for mutual advantage, so that in this way the compressor man may be a desirable adviser for the rock drill man, the pneumatic tool man, the tunnel-driver, and the other air workers.

ROCK DRILL APPRECIATION

The beneficient reach of the rock drill is comparable in extent with that of the steam engine itself, although its fame is much less noised abroad. As a striking generalization it may be said that much less than one per cent of the inhabitants of the earth have ever seen a rock drill, and perhaps not more than one per cent. of those who have actually seen a rock drill have come into intimate relations with it, while, on the other hand, perhaps not more than one per cent. of all who live on the earth have not had their lives affected, and generally betted, by this active agency though to them unknown.

This of course it is not possible to prove, but it still is easily credible. Not all are civilized, but where is the savage whom civilization has not touched, and whose habits and whose modes and means of living have not been affected? Then we have only to remember the status of the rock drill in the van of civilization and our opening assertion proves itself.

In the middle of the last century the rock drill began its lifework as the driver of tunnels, and in a short time it became the most facile instrument in all rock cutting, not only in tunnels and mines perforce, but for all exposed work as well, so that it now has a foremost place in engineering operations, the primary and ultimate purpose of all of which seems to be the facilitating of communication and the hastening of the transfers of our products and acquisitions.

While the rock drill works directly in preparing the way for the locomotive and its train, it indirectly does as much for water traffic also. It cuts canals through rock, does subaqueous work to deepen or widen or straighten ship channels and gets out the stone for piers and docks. All the materials of the steamship, and the coal that drives it, are got by the rock drill, and members of the rock drill family rivet the plates and frames together. Then the cargo which the steamer carries all in one way or another has been touched by the rock drill, and much of it may be said to be exclusively of rock drill creation, as for instance the teeming products of the once arid plains which now have been irrigated through the rock cut waterways, these rich fruits and other good gifts of the soil going to gladden all the earth.

This is no summary of the work of the rock drill but only a hint as to one portion of it. The rock drill needs no advocate or promoter. It pushes its way through the world as its bit pierces the rock. Its work grows before it, and the more it does the more there is for it to do, and especially the greater is the variety of its task, to which it is continually adapting itself by sending out new members of its family with new and special qualifications.

While all in the world reap benefits from the rock drill, and while many when told of its work may attain to some appreciation of its beneficence, only those most intimately in touch with it can really know the measure of it as a product of multifarious and untiring ingenuity in the design, of marvelous skill and precision and care in the manufacture, and of largeness of enterprise in the commercial handling of it. The manufacture of the rock drill, and of all which the name covers, with that of the air compressor which gives it life is one of the world's great industries, which no small and no unexperienced organization can be expected to competently handle. The speed and inertia of the latest steamship is typical of that of the modern manufacturing establishment, and the size of either is a function of success.

PROGRESS ON THE GREAT NEW ZEALAND TUNNEL

Our readers have been reminded from time to time of the Otira tunnel, 5⅓ miles long, which is being driven through the "Southern Alps." Our latest news concerning it comes from Vice Consul Henry D. Baker in *Consular and Trade Reports.* He says:

I recently witnessed construction work at this tunnel, which it is estimated will cost over $3,500,000. There is a grade in this tunnel of 1 foot in every 33 feet upward from the west coast side, which makes it difficult to keep water out of the eastern end, even with much pumping, so that work at this end must necessarily be much slower than at the other end, where the water will easily drain out. From the western side at Otira, in company with the engineer for the work, I went 1½ miles into this tunnel—as far as completed. We were taken in on a train of trucks loaded with concrete, drawn by an American electric locmotive fed with current from an overhead wire. During the last quarter of a mile, where there was considerable work going on and the passage is only partially excavated, it is unduly dangerous to have live wires in the tunnel, so use is made of an ingenious contrivance of an insulated cable wound up on the locomotive, which is made to connect with the trolley wire, and spins out as the locomotive goes on its course, the current being received through this cable and applied to the locomotive, so it continues its uphill course through the tunnel without life being endangered. This interesting locomotive is much used, I understand, in tunnel work and mining operations in the United States, where the engineer in charge, who was formerly employed on the Western Pacific Railway, had occasion to notice its usefulness, and so introduced it into New Zealand.

All the rock building in the tunnel is worked by compressed-air machinery, which is also of American manufacture. Early in the construction of the tunnel, when an accident imprisoned some of the men for about 80 hours, this American machinery pumped fresh air and food into the prison chamber, so that when the men were finally rescued they were little the worse for their trying experience.

Work on the tunnel is proceeding on the same general plan of top headings as in the famous Simplon Tunnel in Switzerland, the top first being cut out, then the bottom, and then all sides trimmed off and finally arched with concrete. The work at the western end now proceeds at the rate of about 12 feet per day. It has been going on for about three years, and may require about five years more to complete. A small water-power plant near the western end drives the machinery, but recently it seems that dry weather has reduced the power below necessary requirement and so interfered with the work.

GROUTING LEAKS IN THE WASHINGTON STREET TUNNEL UNDER CHICAGO RIVER

BY WILLIAM ARTINGSTALL.

In January, 1911, the work [on the reconstruction of the Washington Street tunnel] was sufficiently advanced to permit the operation of street-car traffic. At that time there were numerous leaks through the tunnel walls, which, under the terms of the contract, had to be absolutely watertight. Geo. W. Jackson, Inc., has at this time a force of men engaged in this work, and the method seems to be effective.

A grouting machine, air compressor, electric motor and small derrick mounted on a flat car belonging to the Chicago Railways Co. are run down into the tunnel after midnight. The machine consists of a drum into which the cement and sand are placed and the cover clamped down. Water is then admitted and the mass agitated by means of paddles mounted on a shaft, one end of which, extending through the drum, is fitted with a belt connected to an electric motor A 2-in. hose is connected to a valve in the drum and leads to the connection at the grouting pad.

Where a perceptible amount of water is coming from one spot, the hole is cleaned out and enlarged to about 2 in. diameter. A felt gasket is then placed around the hole and the flange of a 5-in. pipe placed over the opening The grout is forced through a 2-in. pipe fitted with a tee (capped at one end), which is fastened into the pipe. This 5-in. pipe is used only to hold the pad in place and has a jack screw fitted in one end for bracing against the opposite wall.

The amount of grout forced into the hole depends on the size of the hole to some extent, but some leaks take a large amount of cement. The pressure (about 110 lb.) is not kept on continually, but by applying it for intervals of five or ten minutes with a rest of about the same amount of time, grout can be forced into the leak at practically every trial. The pad and jack are left in place until it is necessary to remove them for the first cars passing through the tunnel at 5 a. m.

LATER REFRIGERATION METHODS FOR DRY AIR BLAST

BY JAMES GAYLEY.

In the first method of installing dry air plants, the moisture was extracted by passing the air over coils of pipe, which were cooled to a low temperature by the circulation of brine; and while this method has proved effective in practice, cheaper methods have since been worked out.

On the principle that it is easier to go from one temperature to another by a succession of steps, rather than by a single step, several methods of applying the two-stage system have been evolved, which, while producing the same results, are more economically operated and can be installed much more cheaply.

Fig. 1 shows a two-stage refrigerating chamber, which represents cooling by a combination of direct and indirect contact. One chamber is filled with screens and the other with coils of pipe. These screens may be made of expanded metal lathing, separated by baffle strips, causing the air to pursue a tortuous course. The air passing up through the screens is met with a descending shower of water, which is cooled as closely as practicable to the freezing point. This removes about two-thirds of the moisture. The air then passes up through moisture eliminators, in which any entrained moisture is removed, and afterward passes downwardly over the refrigerating coils. A small stream of brine is allowed to flow over the coils, and this film of brine prevents the formation of frost. Consequently the operation of the chamber becomes a continuous one, and the work done in the coil chamber is practically constant, as the air leaves the first chamber at the same temperature. The cooling water with that from condensation collects in the cooling chamber underneath, where it is kept at a practically contant temperature, and the surplus accumulated by the cendensation of the atmospheric moisture can be used for other condensing purposes.

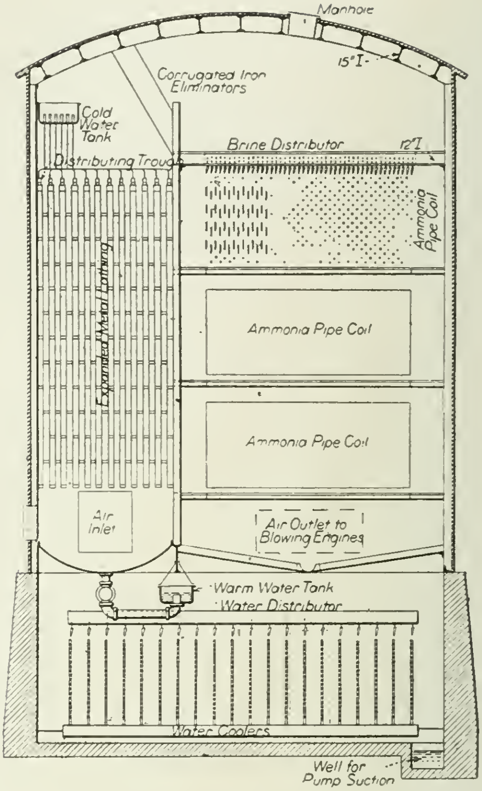
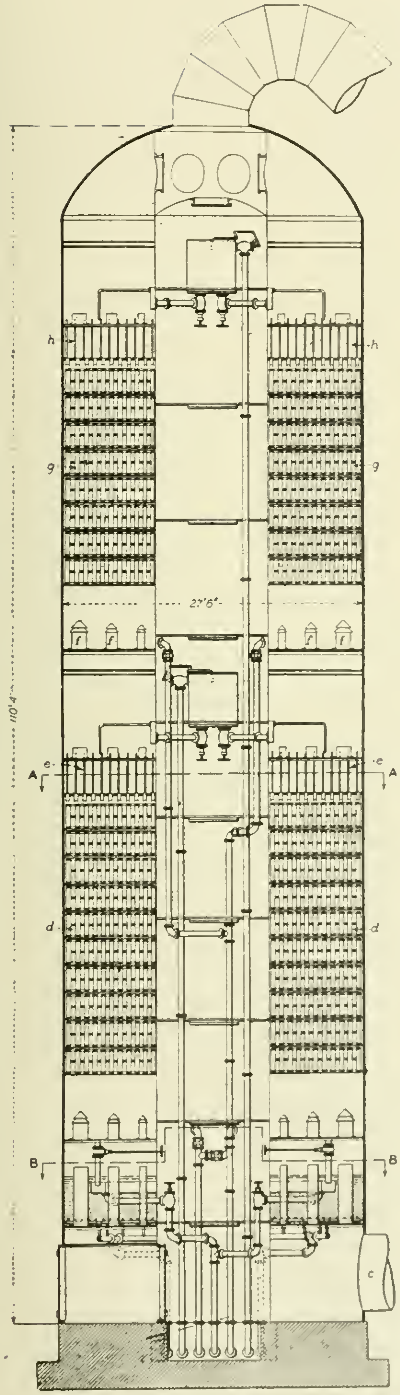


Fig. 2 represents the tall tower type, designed by Bruce Walter, of Pittsburgh, to conduct the refrigeration by direct contact entirely. This has capacity for a furnace requiring 40,000 cu. ft. per min. The air enters at *c* and passes up through pipes to the chamber *d*, which is filled with screens or grids, over which flows a constant stream of cold water. The air is thus brought into intimate



contact with the water and the greater part of its moisture is condensed and removed. Next the air passes through the moisture eliminators *e*, then through the outlet pipes *f* to the brine chamber *g*. In this chamber the air comes in direct contact with brine cooled to a very low temperature, and the moisture is reduce to 1 grain per cu. ft.

The air comes to the brine chamber with a practically constant amount of moisture, and by further cooling additional moisture is condensed and the brine strength is gradually weakened. The revivifying of the brine is not a difficult or expensive matter, for there is plenty of waste heat at the furnace that can be used for this purpose, and a simple apparatus has been devised by Mr. Walter to maintain the strength of the brine, which operates automatically. The center of the tower can be used for a stairway or elevator for use of the workmen, but there is, in the nature of the operation, little to get out of order. The whole method of operation is simple and effective. The tower is built of steel plates, and the cooling fluids come in contact with metal surfaces only, as the insulation is on the outside of the tower.

The work that the fan has to do is that required to lift the air the distance from the fan discharge to the inlet of the blowing engines. The cost of installation by this method, as worked out by several engineers, is about one-half the cost necessary to install under the earlier coil-pipe system, where the moisture was deposited as snow. So the return on the investment is nearly doubled.

In the direct-contact system provision is made for discontinuing the use of the water spray chambers when the natural air temperature, as in the winter season, does not require its use.

In installing the dry-air process, a surplus of refrigerating power above the average requirements is made necessary, to meet the conditions of the high humidity of the summer season, and this provides during the greater part of the year a material surplus of refrigerating capacity, which can be used in other directions. This has been done successfully on a small scale at the South Chicago works of the Illinois Steel Company, in the making of ice for use around the works. There is no reason why this cannot be carried out on a much larger scale, and not only offset the cost of operating the dry-air plant, but also show an additional profit per ton of pig iron.

At nearly all seasons of the year the humidity is less at night than during the day, and the night surplus of refrigerating power could be used for this purpose. Making of artificial ice can readily be made a by-product of the dry-air process in nearly every locality, and by products are profitable.

There is an abundant supply of condensed steam at all iron works, which could be turned into ice of unquestioned purity.—*Condensed from Iron Age.*

USE OF OXYGEN HELMET IN HIGH TEMPERATURES

By H. H. Sanderson.

During the latter part of August a test was made with oxygen rescue apparatus at Virginia City, Nev., which will, no doubt, prove of considerable interest to mining men, especially to those that have similar conditions to contend with.

The test was made at the Ward shaft, which is operated by the Ward Shaft Pumping Association, being worked exclusively for drainage purposes. The shaft is at present about 2,500 feet deep with stations at various levels.

Nearly every one familiar with the mines in this district knows of the excessive heat encountered, especially at the lower levels, and it was the intention of the writer to test the apparatus under the most unfavorable conditions and ascertain if it were possible to wear the helmet in the very high heat.

The Draeger 1910-1911 two-hour helmet type of apparatus was used. It was decided to make the test on the 2,450-foot level and all air was shut off from this level on the night prior to the test. There being some doubt among the mining men as to the strength of the oxygen cylinder, one was charged to 175 atmospheres pressure, which is 25 atmospheres in excess of the regular charge, and placed in the water at the face of the 2,450-foot level, the water registering 165 degrees of temperature. This cylinder remained in the water for over 2 hours without any evidence of change. After assurance of safety from this source, four men, J. D. Moore, superintendent; H. R. Norsworthy, engineer; Ed. Ryan, state mine inspector; and H. H. Sanderson, were lowered to the 2,475-foot level. The men then put on the apparatus and were hoisted to the 2,450-foot level and all men went to the face of the drift, about 300 feet from the shaft. The temperature was about 134 degrees in the drift. On nearing the shaft on the return trip, some of the party felt that the apparatus was not working properly and all were again lowered to the 2,475-foot level. Here the men were cooled off by means of a spray of water coming direct from the surface, and the apparatus examined.

Prior to entering the mine the helmets had been used on the surface for nearly an hour's time in drilling men in a cave filled with sulphur fumes and it was now decided that the cause for the men's discomfort was due to this fact, as the air regenerators were not fresh when the test began. It was therefore decided to make a second try-out and the party again made preparations to descend the shaft. The oxygen cylinders were recharged and the new air regenerators placed in all apparatus. The helmets were put on before leaving the surface and the men lowered direct to the 2,450-foot level. Here it was found that the heat had increased to about 145 degrees. All went to the drift face and remained on the level about 20 minutes without the least discomfort from the helmet and all of the party agreed that, if necessary, this time could have been doubled. While the excessive heat could be felt very plainly on the body and hands, the face and head were kept cool, this being especially noticeable when the helmets were removed where the temperature of the surrounding air was about 100 degrees.

Members of the party wore very heavy woolen suits and heavy canvas gloves. On removing the gloves it was found to be impossible to bear the hand on any of the metal parts of the helmet or apparatus, and the water and rock were too hot to touch.

The test demonstrated two things: First, that in case of fire or bad air in any of the mines in this district it would be possible to enter the mine and work with the apparatus even though the heat was very great. Second, that while working under such conditions, new air regenerators should be used, and if possible changed every 30 or 45 minutes. The length of life of these regenerators could be lengthened by taking an extra one into the mine and exchanging them about every 15 minutes.—*Mines and Minerals.*

NOTES

To prevent rubber packing from blowing out cut pieces of ordinary wire window screen the size of the packing and place on each side of it. The wire beds itself into the soft packing and holds it in position.

Plans are being formulated for constructing a railway from Cape Town to the top of Table Mountain, at whose base the city lies. The mountain is about 3,500 feet high.

Among the exhibits at the recent automobile show in New York was the largest pneumatic tire in the world. It was a 38 by 8 inch Nobby Tread made at the Morgan & Wright factory in Detroit. The tire was a sample of a limited number made for test work on heavy trucks. Four of these giant Nobbies have been in use on a heavy truck for some time, and beyond a few punctures they have given no trouble. The shoe weighs 100 pounds and the tube 15 pounds.

In the overhead coal storage of a mill at Lawrence, Mass., is a concrete ash bunker, in the form of an inverted pyramid some fifty feet across, made sufficiently air tight to allow a vacuum of fourteen inches of water to be maintained in it. Into this the ashes are drawn by suction from the ashpits. Some time ago an explosive mixture of gas was drawn over from the boilers or generated from the ashpit refuse which became ignited in the bunker and exploded with considerable violence.

Several French physicians advise all airmen attempting altitude records to carry with them a supply of compressed oxygen and an inhalation mask. The cylinders should be provided with a simple regulator allowing about three, four or five quarts to flow out per minute. Distress on account of the rarefied air is not usually felt at altitudes under 13,000 ft., but because of the strenuous nature of an airman's work, it may be felt sooner. Several instances of distress at an altitude of but 11,000 ft. have been recorded in France.

The United States Geological Survey during the course of its topographic surveys, which now cover nearly two-fifths of the area of the United States, has determined a large number of exact elevations and they are now being published in a series of bulletins, each covering either a single state or a group of states. This series of bulletins, though constituting by no means a complete dictionary of altitudes of the United States, gives the exact elevation of many thousands of points, including a large number of towns, hills and mountains of prominence.

It is calculated that 69 per cent. of all railway earnings in the United States is derived from freight, while 23 per cent. is from passengers, and 8 per cent. from miscellaneous sources. About two-thirds of the gross earnings of railways are consumed in their operation, leaving one-third for fixed charges, dividends on stock, and for betterments and improvements. The railways of the United States employ 1,500,000 persons, at a cost of about $1,000,000,000, equal to 35.7 per cent. of the gross earnings.

Blackdamp is often treated as synonymous with carbon dioxide, and this error has led to much confusion. Blackdamp, as ordinarily met with, is simply nitrogen mixed with from about 5 to 20 per cent. of carbon dioxide. It is the residual gas resulting from various oxidation processes in mines and the surrounding strata. The oxygen is consumed, leaving, of course, nearly four times as much nitrogen, while the amount of carbon dioxide formed depends on the nature of the substance oxidized, and on other conditions.

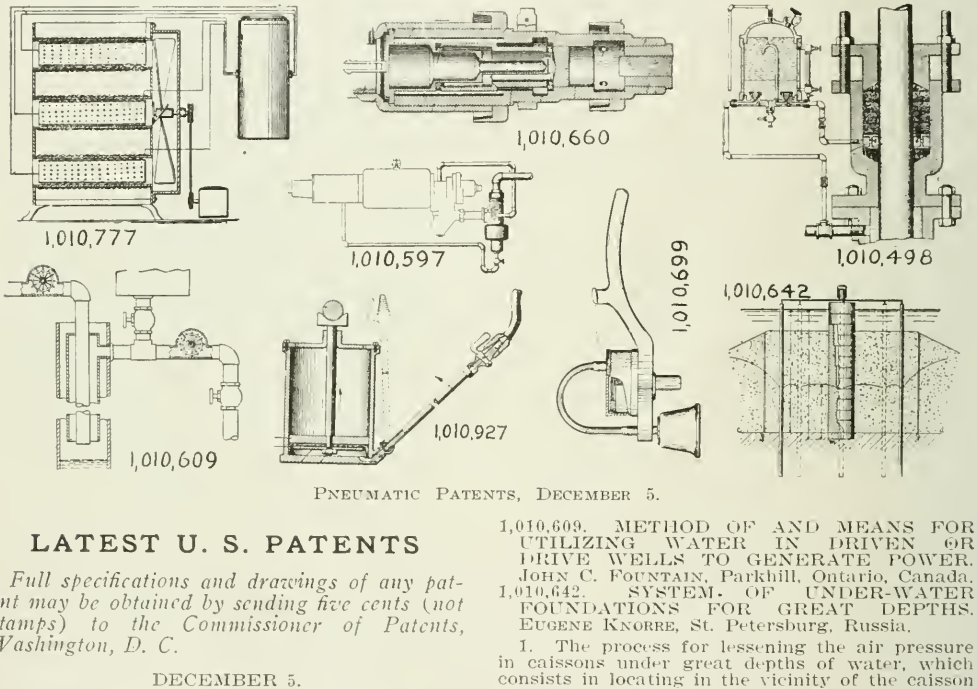
The Meteorological Service of Canada has been making observations of the upper air with sounding balloons since February last, and has achieved some excellent results. Of sixteen balloons sent up, eight have been recovered to the present writing The altitudes attained have varied from 11.2 to 23.2 kilometers (about 7 to 14 miles). The isothermal layer was found at an average height of 13 kilometers (8.1 miles). The lowest temperature recorded was 70 deg. below zero Cent. (94 deg. below zero Fahr.) at an altitude of about 8.7 miles.

At the Talisman mine, Karangahake, N. Z., a 3⅛-in. piston drill weighing 300 lb., making with ordinary drill steel four hundred 5½-in. strokes per minute with air at 80-lb. pressure, was used for drilling holes for the foundation bolts of a Cornish pump. These bolts were 6 in. diameter. Hexagonal drill steel 2 in.

diameter was used. The starting bit was 6⅝ in. diameter. The finishing drill was 6 in. diameter, 7 ft. long and weighed 84 lb. The drilling was done at the rate of 1 ft. per hour in hard andesite.

A German inventor proposes to enrich the air entering a blast furnace by passing it over barium dioxide, which, at temperatures ranging between 600 and 900 degrees Cent., gives off oxygen. The air is first dried and freed from carbon dioxide and then heated to the required temperature in a Cowper stove. After the supply of barium dioxide is used in the enriching process, the substance is subjected to the action of an air blast at a temperature of 350 to 500 degrees Cent. This regenerates the monoxide, converting it into the dioxide.

It is calculated that in the next three years, for the sinking of the shafts and the drivng of the tunnel sections under Manhattan for the new Catskill aqueduct, the consumption of dynamite will be at the rate of 1000 pounds per day for each of the twenty-four shafts, this making a total of 21.000,000 pounds of dynamite. Extraordinary precautions are taken to safeguard the workers and the city.



Pneumatic Patents, December 5.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 5.

1,010,456. METHOD OF EVACUATING VACUUM APPARATUS. Otto Schaller, Sudende, near Berlin, Germany.

1. The method of securing high vacua in vacuum apparatus, which consists in preventing the presence therein of vapors of the liquid employed in the exhaust pump used in evacuating it by refrigerating the exhaustion system.

1,010,498. LUBRICATING DEVICE. William H. Hultgren, Philadelphia, Pa.

2. An automatic lubricating device consisting of a closed chamber, an oil discharge passage from the oil space in the chamber provided with a check valve, a pressure supply pipe communicating with the lower part of the chamber and also provided with a check valve, a drain valve at the bottom of the chamber, and a compressed air pipe communicating with the chamber for supplying compressed air from an outside source to the upper portion thereof.

1,010,597. AIR-BRAKE. Carl R. Daellenbach, Braddock, Pa.

1,010,609. METHOD OF AND MEANS FOR UTILIZING WATER IN DRIVEN OR DRIVE WELLS TO GENERATE POWER. John C. Fountain, Parkhill, Ontario, Canada.

1,010,642. SYSTEM OF UNDER-WATER FOUNDATIONS FOR GREAT DEPTHS. Eugene Knorre, St. Petersburg, Russia.

1. The process for lessening the air pressure in caissons under great depths of water, which consists in locating in the vicinity of the caisson a series of tubes extending below the bottom of the caisson and continually pumping the water from the tubes.

1,010,660. FLUID-PRESSURE TOOL. Albert C. McFarlane, Colorado Springs, Colo.

1,010,699. PNEUMATIC MASSAGE - TOOL. Charles O. Sobinski, St. Louis, Mo.

1,010,726. LOW-PRESSURE TIRE-SIGNAL. Joseph M. Collins, Gorman, Tex.

1,010,777. OZONIZER. Ross Mortimer Leggett, Ann Arbor, Mich.

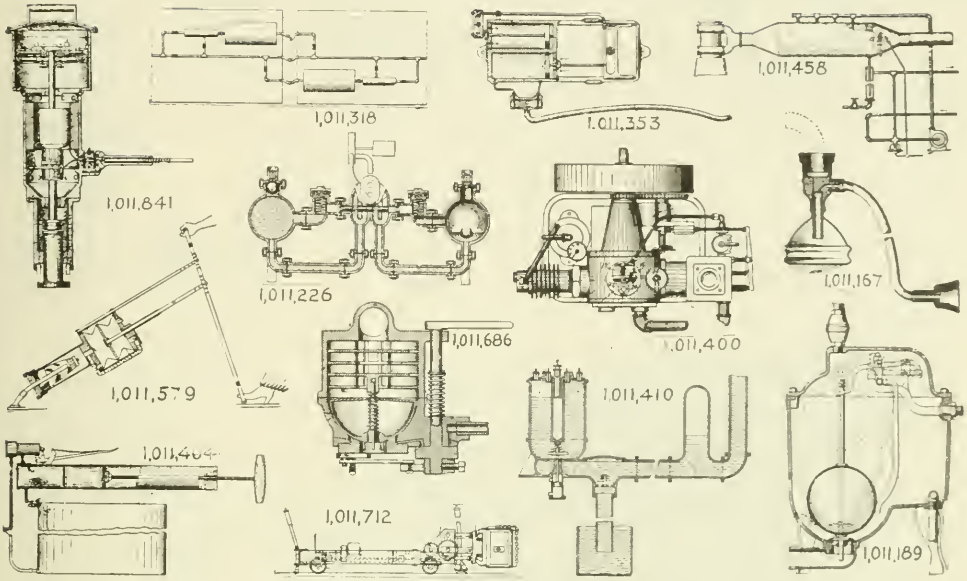
1,010,927. PNEUMATIC JACK. Clarence H. Letcher, San Jose, Cal.

DECEMBER 12.

1,011,167. MASSAGING APPARATUS. Henry Dark, Philadelphia, Pa.

1,011,189. AIR-COMPRESSING APPARATUS. William U. Griffiths, Philadelphia, Pa.

1,011,226. COMPRESSOR FOR REFRIGERATING APPARATUS. George W. Miller, Philadelphia, Pa.



Pneumatic Patents, December 12.

1,011,318. VALVE FOR AIR-BRAKE SYSTEMS. Charles W Carroll, Kola, Miss.

1,011,353. AUTOMOBILE TIRE-PUMP. Otto W. Linstrum, Hoopeston, Ill.

1,011,400. AIR-COMPRESSING PLANT. Oscar M. Bergstrom, Minneapolis, Minn.

1,011,404. LIQUID-SPRAYING DEVICE. Peter Brandt, Chisago City, Minn.

1,011,410. METHOD OF OPERATING INTERNAL-COMBUSTION PUMPS AND COMPRESSORS. Henry M. Chance and Thomas M. Chance, Philadelphia, Pa.

1,011,458. HUMIDIFYING APPARATUS AND MEANS FOR CONTROLLING THE SAME. Joel Irvine Lyle, Plainfield, N. J., and Edward T. Murphy, Philadelphia, Pa.

1,011,460. PNEUMATIC TREAD FOR BOOTS AND SHOES. Edward Maddocks, Toronto, Ontario, Canada.

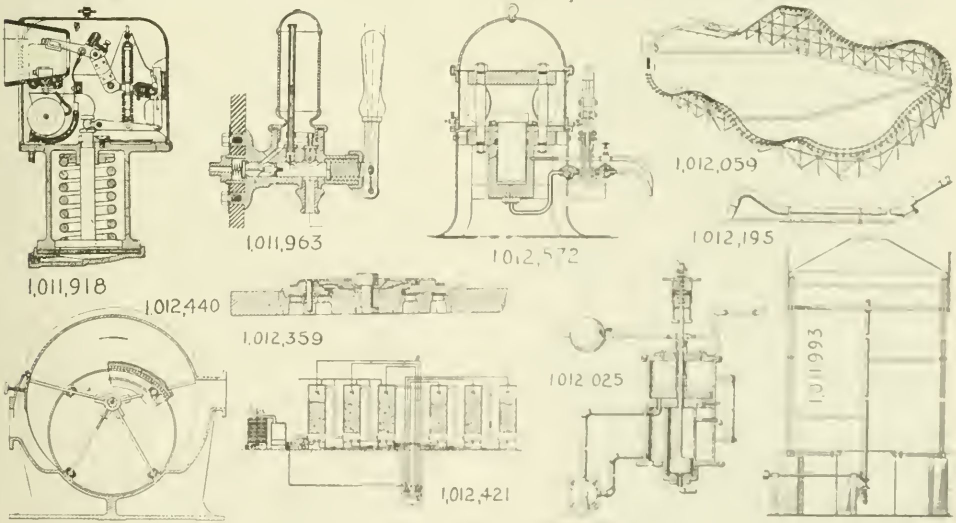
1,011,579. SUCTION CLEANING DEVICE. Walter S. Cheston and Thomas A. McIntyre, Jr., New York, N. Y.

1,011,686. FLUID-VALVE. Walter C. Westaway, Rockford, Ill.

1,011,712. TUNNEL-EXCAVATING MACHINE. John Nels Back, Seattle, Wash.

1,011,841. PORTABLE ELECTRIC ROCK-DRILL. John Albert Pierson, Pigeon Cove, Mass.

1. The combination of a reciprocating tool chuck, a motor including a rotary and reciprocatory element connected with the chuck, and pneumatic means actuated by the said motor element for producing reciprocation thereof.



Pneumatic Patents, December 19.

DECEMBER 19.

1,011,918. FLUID-PRESSURE GOVERNOR. HERBERT W. CHENEY, Milwaukee, Wis.

1,011,928. MINING-MACHINE. HOWARD N. EAVENSON, FREDERICK D. BUFFUM, and JEFFERSON E. FLEXNER, Gary, W. Va.

1,011,963. APPARATUS FOR THE DELIVERY OF AERATED LIQUID FROM BULK. ALGERNON BROOKER JACKSON, London, England.

1,011,989. VACUUM CLEANING APPARATUS. OTTO H. MOHR, San Francisco, Cal.

1,011,993. DESICCATING APPARATUS. WILLIAM S. OSBORNE, New York, N. Y.

1,012,025. GOVERNOR FOR ENGINES. JOHN C. STIER, Mason City, Iowa.

1,012,059. ELECTROPNEUMATIC BRAKING APPLIANCE FOR RAILWAYS. MAYO H. BURCHARD, Chicago, Ill., and ROBERT P. NOBLE, Portland, Oreg.

1,012,195. SUCTION-CLEANER. FREDERICK A. ENGLISH, Chicago, Ill.

1,012,359. VALVE FOR BLOWING-ENGINES. LORENZ IVERSEN, West Homestead, Pa.

1,012,414. HUMIDITY-CONTROLLING APPARATUS. EDWARD T. MURPHY, Philadelphia, Pa.

1,012,421. MANUFACTURE OF SULFURIC ACID. CARL OPL, Hiuschau, Austria-Hungary.

1. The herein described improvement in the art of manufacturing sulfuric acid without lead chambers, which consists in passing the burner gases containing sulfur dioxid under pressure into a system of reaction towers and producing a rapid circulation of nitrous sulfuric acid through the system of feeding compressed burner gases and compressed air to the acid eggs to raise the nitrous sulfuric acid into the towers and to come into intimate contact with the said acid, whereby oxidation of the burner gases is effected.

1,012,440. ROTARY BLOWER. EDWARD P. REICHHELM, Bayonne, N. J.

1,012,572. PROCESS FOR THE EXTRACTION OF OILS AND FATS. WILLIAM SPEIRS SIMPSON, London, England.

The herein described process of extracting oils and fats from vegetable or animal substances which comprises placing a charge of the substance to be treated in a closed chamber, extracting atmospheric air from such chamber, and subsequently compressing the substance *in vacuo* in said chamber to complete the extraction of the oils or fats therefrom and thereby preventing oxidation.

DECEMBER 26.

1,012,578. METHOD OF DESICCATING MILK. HARRY IRVING ANDREWS, Darien, Conn.

1. The herein described process for desiccating milk, comprising the following steps, namely mixing the milk while under a gravity flow with ozone, then subjecting the milk while under gravity flow alternately to the action of heat and cold to evaporate the moisture in the milk, then congealing the milk and forming it into strips, then breaking the strips of milk into small pieces and finally reducing the same to powder.

1,012,693. DISTRIBUTING-VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.

1,012,694. TRIPLE VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.

1,012,701. FLUID-PRESSURE REDUCER. THOMAS O. PERRY, Oak Park, Ill.

1,012,720. FLUID-PRESSURE-BRAKE SYSTEM. WILLIAM H. SAUVAGE, New York, N. Y.

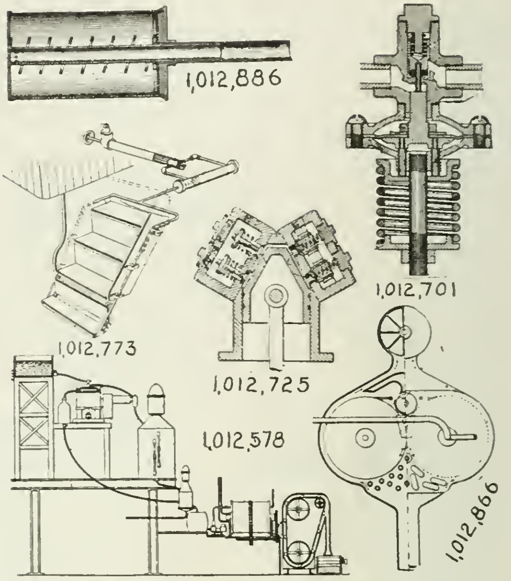
1,012,725. MOTOR AND COMPRESSOR. CHARLES E. SHADALL, Milwaukee, Wis.

1,012,757. BRAKE-PIPE-VENT-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,012,758. DUPLEX PRESSURE-CONTROL APPARATUS. WALTER V. TURNER and WILLIAM M. CADY, Edgewood, Pa.

1,012,759. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,012,760. HIGH-PRESSURE EMERGENCY-BRAKE. WALTER V. TURNER, Edgewood, Pa.



PNEUMATIC PATENTS, DECEMBER 26.

1,012,773. PNEUMATIC CAR-STEP. WILLIAM FRANKLIN WEATHERLY, Campbell, Mo.

1,012,800. VACUUM CLEANING-MACHINE. CHARLES BOYER, Marengo, Ill.

1,012,821. APPARATUS FOR SUPPLYING FLUID-PRESSURE. HENRY H. CUTLER, Milwaukee, Wis.

In combination, a compressor, a motor for operating said compressor, an electromagnetic clutch for connecting said motor to said compressor, a generator driven by the motor for supplying current to said clutch, controlling means for said clutch comprising a solenoid having a core and a switch operated by said core to complete the clutch circuit, a maintaining circuit for said solenoid including an economizing resistance, a pressure switch having two operative positions, a switch operated by the core of the solenoid and co-operating with the pressure switch in one position to short circuit said resistance, and another switch operated by said core and co-operating with the pressure switch in its other position to short circuit said solenoid.

1,012,866. ART OF DRYING LIQUIDS. JOHANNES KUNICK, Berlin, Germany.

The herein described method of extracting, in dry form, from liquids, solid substances contained therein, consisting in spreading the liquids in a thin film on the surface of a cylinder, rotating the cylinder continuously, heating the cylinder internally, sucking a current of air through a contracted passageway partly surrounding said cylinder so as to cause the air current to flow over the entire surface of the film of liquid and with such suctional force as greatly to rarefy the same, and so controlling the temperature of the cylinder-surface and the temperature and velocity of the air current that practically all moisture is evaporated during one revolution of the cylinder and the resultant temperature given to the liquid during this drying operation by the cylinder and the air current being such that the substance being evaporated will remain below 100 degrees C. (212 degrees F.).

1,012,886. BLOWER FOR PNEUMATIC SIGNALS. CORNELIUS S. MCQUEENEY, Akron, Ohio.

1,012,898. AIR-VALVE FOR PNEUMATIC TIRES. FREDERICK M. NEAL, Bridgeport, Conn.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XVII MARCH, 1912 No. 3

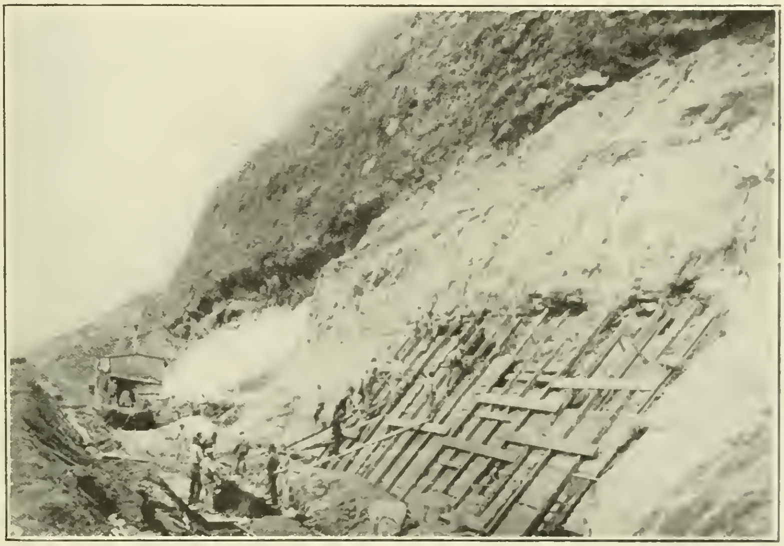


FIG. 2. CEMENT GUN AT WORK ON PANAMA CANAL.

THE CEMENT GUN

BY WILLIAM A. JORDAN.*

Following the first commercial exploitation of cement, considerable time elapsed before the value of concrete was generally recognized. Judged by laboratory tests, where the necessary ingredients of mortar or concrete could be perfectly proportioned and carefully incorporated, results were fairly satisfactory; in practice, however, even up to the present time it has never been possible to closely approximate laboratory results.

For example, taking so simple an operation as the mixing of cement mortar, composed of one part of cement and two of sand, in practice it will be found difficult, if not impossible, to obtain the desired consistency if the theoretical amount of water required to temper the mass is used. On the one hand the theoretical amount of water forms a mortar too stiff to handle, while, on the other hand, any excess of water weakens the mortar by causing voids equal in extent to the bulk of unabsorbed water present.

In the cement gun process, no excess of water can remain in the mortar to later cause voids, neither is it possible for the finest particles of the cement to begin to set before the mortar is placed. Experiments have proved that when cement mortar is tempered with water at the instant that it is deposited in

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*Abstract from Transactions of American Society of Engineering Contractors.

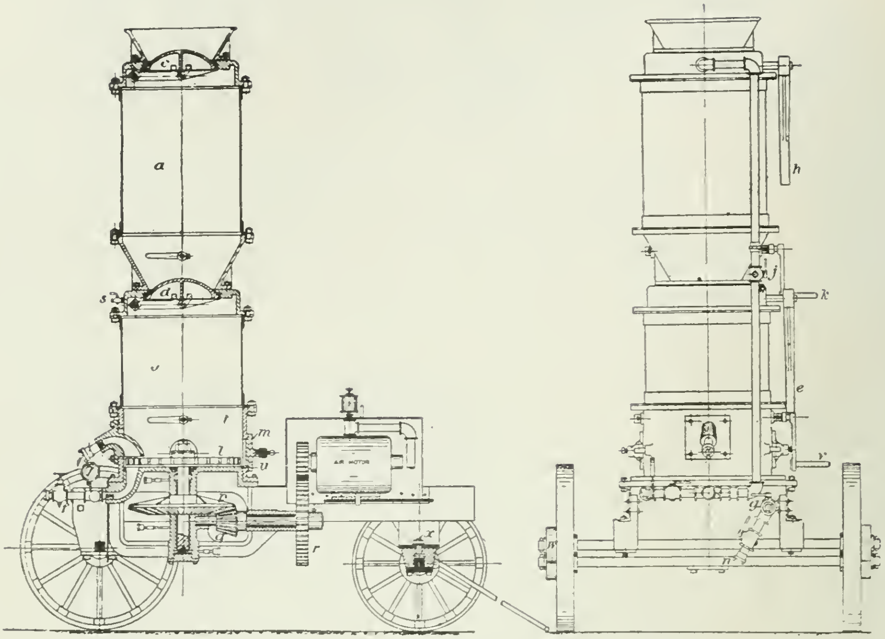


Fig. 1.—CROSS SECTION OF CEMENT GUN.

Dry mixed material placed in cylinder "a." Valve "c" closed and air pressure equalized in cylinders "a" and "b." Valve "d" opened and material drops into lower cylinder "b." The process is then repeated. The feed wheel "s" is revolved by an air motor through the gears "r" and "p." Compressed air admitted through valve "f" blows the material upward and out through the goose-neck shown above the air pressure gauge into a flexible hose.

place, the strength of the mortar is greatly increased. This increase in strength is due to more perfect mixing, to the elimination of loss by the premature setting of a considerable portion of the particles of the cement, and to the greater density of "gun" placed mortar.

It is well understood that perfection in certain arts can be achieved only by the skilled hand and trained eye of the master craftsman. It is not desirable to substitute the precision of a machine for the chisel of the sculptor or the brush of the painter. But in certain industrial arts, the hand worker, however skilled he may be, must be aided and supplemented by machinery. It is not so long ago that the invention of the first power loom, forever ended the toil of countless hand weavers, and it is still within the memory of men when the sickle was for all time retired by the modern reaper.

Among the various materials used in building construction, Hydraulic Cement appears to be one for which machine application might be most rationally expected, and accordingly, it is with this material that inventors have experimented more extensively than with any other. The solution of the problem came with the discovery of the so-called "Cement Gun." As a matter of fact, this is not a "gun" in the ordinary meaning of the word, but it was so designated from the fact that the material is projected from the nozzle with considerable force and literally "shot" into place.

BEGINNING OF THE CEMENT GUN.

Strange to relate, the apparatus was not invented by an engineer or a cement worker, or even by a contractor or builder. It was originally conceived by Mr. C. F. Akeley, a taxidermist of Chicago. His idea for the use of the Cement Gun was to rapidly and economically build up forms over which the skins of the larger mammals such as elephants and hippopotami might be placed.

Mr. Akeley was also a member of the Field Museum Committee and had charge of the remodeling and preserving of one of the old World's Fair buildings in Jackson Park, Chicago, that had been given to the Field Museum Association. He conceived the idea of enlarging the cement gun and then covering the entire building with stucco work by means of it. The experiment was highly successful and the work was performed rapidly and well within the estimated cost.

FIG. 3.

This first practical work done by the cement gun at once demonstrated its possibilities beyond a doubt. The apparatus was then studied in the laboratory and subjected to various practical tests. Also different types of "guns" have been developed and changes have been made as experiments have suggested.

The cement gun, Fig. 1, consists essentially of a hopper into which the cement materials are placed, a hose connected to the bottom of the hopper through which the dry mixture is forced by compressed air, and a specially designed nozzle at the end of the hose to which another hose supplying water is attached.

The dry materials are forced through the hose by the air pressure, hydrated at the nozzle, and shot into place with a muzzle velocity due to a pressure of 35 pounds. The resulting product is of a quality never before attained by any other machine process or by hand. The combination of the elements, cement and water, necessary to produce the plastic material, takes place in transit and the latter is not disturbed after it is placed.

It is a well known chemical fact that the instant water is brought into contact with cement, the initial set, or the chemical combination begins. This initial set must be looked upon as the commencement of that hardening which gives the mass its ultimate strength. Hence, subsequent manipulation tends to disturb this initial set, and consequently must weaken the product. These objectionable features are entirely overcome by the cement gun process; the hydration taking place in transit and immediately before and during emplacement, and the chemical combination or initial set taking place where it belongs; i. e., in its final resting place and not on the mixing board.

The Cement Gun employs or appropriates only the necessary amount of water for the hydration of the cement, and because the materials are projected with considerable force, all surplus water and air are expelled. The product is a non-porus, impermeable mass, possessing the maximum density, and by reason of these qualities, it is practically waterproof.

That the remarkable results attained thus far are possible may be explained as follows: Consider for a moment the constitution of an ideal concrete. We will assume that that part of the mass, consisting of broken stone and sand, is so proportioned, relatively to size and fineness, that it contains the least possible percentage of voids. An ideal mixture would result if cement in sufficient quantity were added to completely fill every void, to perfectly surround and cover each stone and each particle of sand, so that no two surfaces of either sand or stone, throughout the entire mass were in direct contact. Thus graded, and with the use of no more water than the amount actual-

FIG. 4.

ly required for the perfect hydration of the cement, the mixture would constitute the ideal concrete.

We are all familiar with the Sand Blast; a powerful current of air into which, at some point prior to its escape at the nozzle, sharp, clean sand is introduced. The escaping current of air imparts a high velocity to the particles of sand as they leave the nozzle, the force exerted being sufficient to cause them to quickly wear away any hard, unyielding substance against which the blast may be directed, such as iron casting, stone, etc. If, instead of being projected against a hard substance, a sand blast is directed against a surface of a comparatively soft and sticky nature such as ordinary wax, a very curious and unexpected thing happens. The particles of sand, instead of instantly tearing and wearing the wax away, as might be expected, penetrate the surface and stick, thus becoming a part of the mass itself. This process is continued until the wax is, as it were, saturated, and no more sand can find lodgment therein; in other words, the wax arms itself against attack with the sand itself, and thus the most powerful sand blast is rendered harmless.

Let us consider now what might be expected to happen if a certain proportion of powdered wax were introduced into the air blast with the sand, and the combined material directed against some hard surface, a sheet of boiler iron, for instance. Of course, the first particles of sand would strike the iron and bounce off, much as a pebble does when thrown against a wall; but, being soft and sticky, every atom of wax would adhere, and within a few moments the entire surface of the iron would be protected by a thin coating of wax. After this coating had become thick enough to enable the grains of sand to embed themselves threin, they would cease to bounce off as at first, but would stick and become a part of the mass or coating itself. It is easy to understand that, if the process were continued, the sand and wax could be made to form as thick a coating on the surface of the iron as might be desired.

If in the above experiment in place of wax we introduce cement and water, the operation of the Cement Gun is easily comprehended. When the nozzle is first directed against any hard surface, the particles of sand do not at first adhere; they fall away until a coating of cement sufficiently thick is formed to enable the sand to embed itself. The importance of this feature will be better understood when it is realized that the effect in practice is to deposit a thin layer of practically neat cement where the new work joins the old, and after hardening, if a test piece is broken, it will be found that this joint or initial surface of adhesion is the strongest part of the mass.

When considering "gun" made concrete, it should be borne in mind that the powerful air blast imparts a great velocity to the particles of sand. By means of the sand blast, ordinary dry sand will wear its way through iron or steel with incredible speed. In the Cement Gun the high velocity imparted to the mixture of sand, cement and water as it is thrown upon a surface to be coated is of the utmost importance in producing a concrete of maximum density.

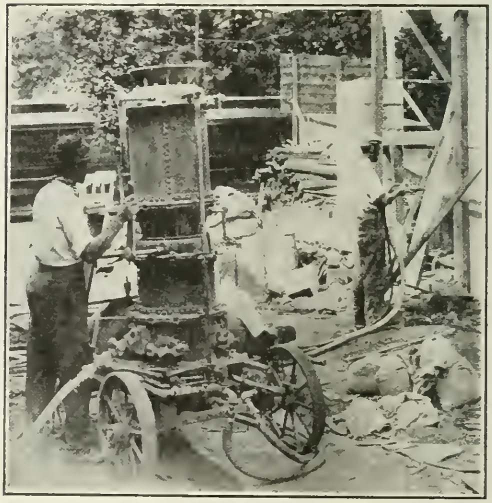


FIG. 5.

In the cement gun the sand and cement are first mixed together in correct proportion while dry. This dry compound is deposited in the hopper, from which it is fed into a powerful blast of air which conducts it through a suitable length of ordinary rubber hose until the nozzle is reached. Here, in the form of a fine spray, the water necessary for hydration is added at a pressure slightly in excess of the air pressure. The velocity with which the materials are traveling, however, is so great —300 feet per second—that hydration in reality takes place in the air, after leaving the noz-

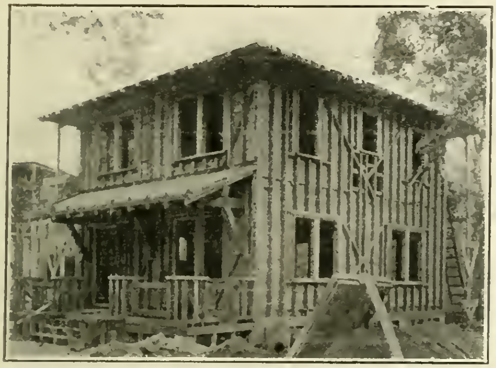


FIG. 6.

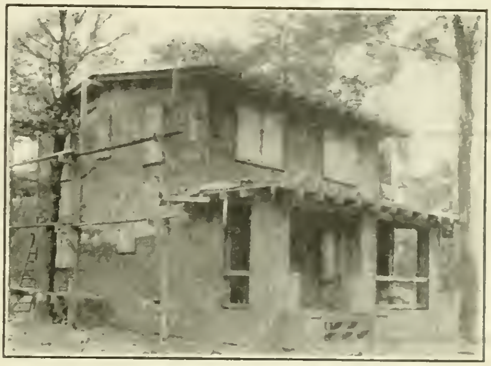


FIG. 8.

zle, and is completed as the mixture is deposited. It is, of course, impossible to regulate the water thus admitted to precisely the amount theoretically required, as a very small variation in the air pressure alters the amount of dry material flowing from the machine, nor is such fine adjustment necessary or advisable. The mixture of sand, cement and water strikes the object or surface on which it is deposited with such force, that any surplus water contained is continually driven to the surface and flows away, just as in tamping and ramming a mass of wet concrete, a percentage of the surplus moisture is forced to the surface.

The cement gun has been used on a number of engineering projects very successfully. Probably the most prominent place where the Gun has been used is the Panama Canal. Here it was employed to coat the disintegrating rock of the Culebra cut with concrete. See Fig. *2*.

The New York Central & Hudson River R. R. Co. are using the cement gun process for coating the steel work in their new 42nd street terminal. This work has been done without forms, or centering of any kind, and a coating of two to three inches of concrete has been applied to all structural members. It is necessary that steel be thoroughly clean and free from rust. On account of vibration from trains, the concrete is reinforced with various sizes of wire mesh.

The sea wall at Lynn, Mass., was repaired by Mr. J. R. Rablin, Chief Engineer of the Metropolitan Park Commission, in a very satisfactory manner by means of the cement gun. Here it was necessary to contend with the tides, but it was found that they had no effect when the cement was once in place.

The engineers of the Water Supply Department of the City of Baltimore have investigated the Cement Gun Process and have decided that it could be used to advantage for lining an 8 mile brick water tunnel, between the new dam at Loch Raven and the City of Baltimore. This tunnel is being changed from a gravity tunnel to a pressure tunnel. In the

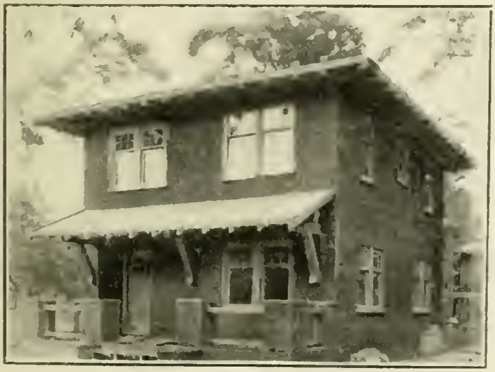


FIG. 7.

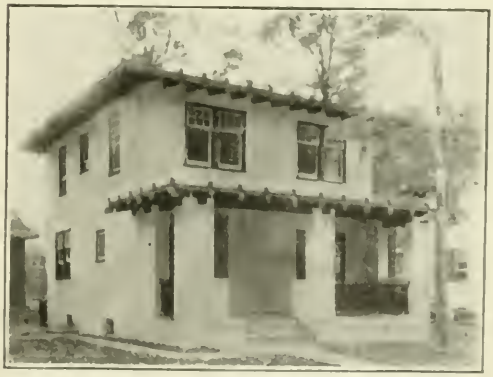


FIG. 9

case of this water tunnel, it will be necessary to work four hours and allow the concrete to set during four hours, and then turn the water on. We have thus seen that not only have we now an apparatus which enables us to deposit concrete in various ways not hitherto found practicable, but also with the same apparatus we can obtain a concrete which has qualities and properties not secured with the best hand or machine made mixtures.

Whereas formerly, concrete layers less than a few inches thick could be deposited only by means of slow, laborious and costly methods, either by plastering, or, if space allowed, by means of comparatively expensive molds or forms, the same result may be accomplished with great rapidity and with the most flexible of tools,—a blast of air. Again, while with hand plastering it is practically impossible to secure a uniform deposit that will resist the forces of nature which tend to destroy the continuity of such a coating from the moment it is made, the concrete deposited through the agency of one of those destructive elements itself is so homogeneous, dense, and cohesive that even the flames cannot destroy its continuity.

The following notes are appended in further explanation of the illustrations:

Fig. 2. Concrete gun at work on the Panama Canal. Concrete re-enforcement necessary to prevent the falling of overhanging andesite. Original method shown on the right, concrete gun at work on the left. Thickness of hand-made revetment wall, 4 inches to 4 feet. Average thickness of gun concrete, 2 inches. Cost of gun work, less than 20 per cent. of hand work per unit of area.

Fig. 3. Sea wall at Lynn, Mass., showing destructive work of tides and storms.

Fig. 4. Same sea wall patched and repaired by the cement gun.

Fig. 5. Cement gun in action, coating concrete block houses.

Fig. 6. Wooden frame of house designed to be covered with stucco applied by the cement gun process. Wooden lath and hand plastered on the inside.

Fig. 7. Second stage in the cement gun process. The above frame covered with building paper and reinforcing wire.

Fig. 8. (Not the same house). First coat of stucco applied to house. Note style of scaffolding, method of covering windows and corner strips.

Fig. 9. The finished concrete house as left by the concrete gun. No hand work necessary to complete work of gun.

TEAM BELOW ATMOSPHERE COMPRESSING AIR TO ONE HUNDRED ATMOSPHERES

A compressed air haulage system has been installed in the mines of the Bergban colliery, New-Essen, Germany, using the exhaust steam from the colliery hoisting engines for running the compressor. The ultimate work of the compressor was the supplying of five pneumatic locomotives each having 170 ton-miles of work per day, the storage pressure required being 1,470 lbs., or 100 atmospheres, and the compression being performed in four stages.

Figs. 1 and 2 are a plan and a side elevation respectively of the compressor. The arrangement, it will be seen, nicely balances the work on the two sides of the machine. The first and the third-stage air cylinders are arranged in tandem and driven by one steam cylinder (on the near side in Fig. 1) while on the other side of the balance wheel the second- and fourth-stage air cylinders are driven in tandem by the other steam cylinder. The first-stage air cylinder is approximately 15 in. diam., is double-acting, and is designed to bring the air up to a pressure of 42½ lb. per sq. in. From this cylinder, the air passes to the second-stage double-acting cylinder, of 8½ in. diam., where it is brought to a pressure of 176 lb. per sq. in. The third- and fourth-stage cylinders are both single acting and of 6 in. and 3½ in. diam. respectively. Air leaves the third-stage cylinder at 500 lb. per sq. in. and the fourth stage at 1,470 lb. per sq. in. pressure. The four air cylinders are connected by three intercoolers of ample capacity.

The steam cylinders, on the opposite sides of the crank shaft, are rigidly fastened to the same bedplate as the air cylinders which they drive. They have a diameter of 43½ in. and are equipped with a simple and perfectly balanced piston valve gear. The size of these cylinders is sufficiently great to admit of the engine's running, not only with steam of atmospheric pressure but also with steam having an absolute pressure considerably below that of the atmosphere.

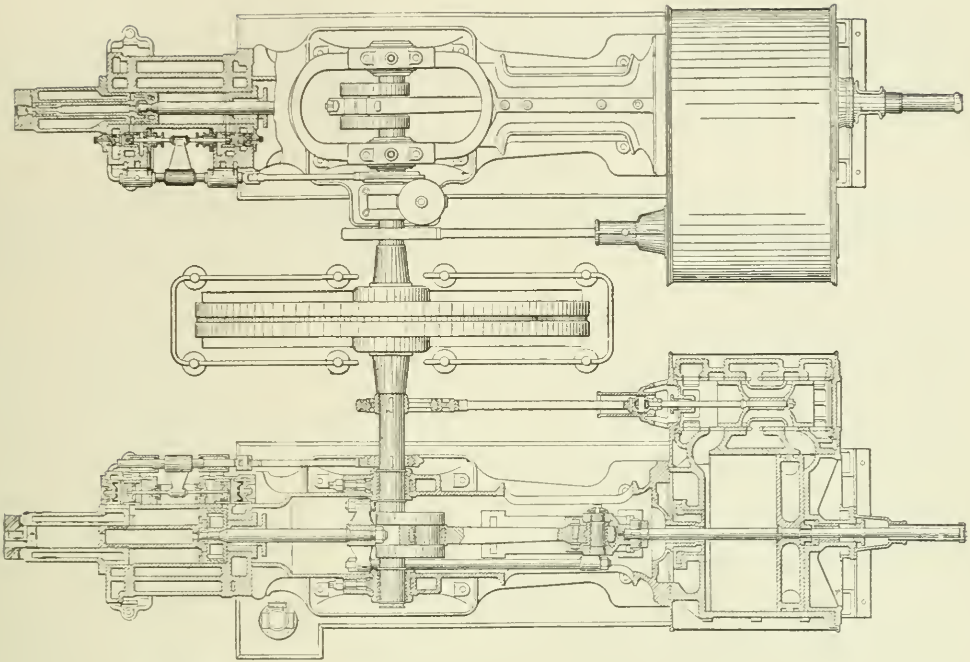


FIG. 1.

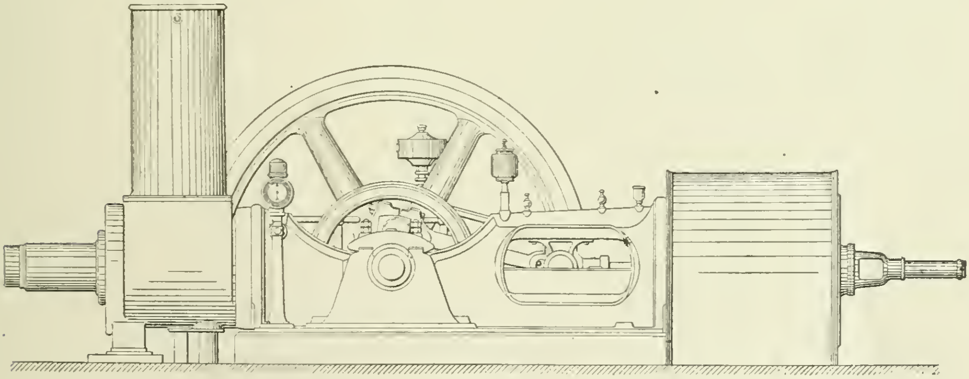


FIG. 2.

In operation, the exhaust steam from the hoisting engines passes through pipes of 24 in. diam. to a heat accumulator, attached to which there is an oil separator with an automatically working discharge. From the accumulator the steam passes directly to the valve chests of the steam cylinders of the compressor. After expansion in these cylinders to about 3 lbs. per sq. in. abs. pres., it is drawn off into a central condensing plant, which maintains a vacuum of about 25.6 in. and is equipped with a piston air pump. The steam cylinders of the compressor are made large enough, as before noted, to work with a pressure as low as 10¼ lb. abs., per sq. in., and thus not only is the usual back pressure of 1½ to 3 pounds absent from the exhaust passages of the hoisting engine, but frequently, after a pause in the hoisting, a vacuum of as much as 6 or 8 in. is found. Therefore, this engine starts more easily, and more quickly gains its highest speed than when exhausting into the atmosphere. As a matter of fact, however, in the actual running of this plant, the foregoing condition of the partial vacuum in the hoisting-engine exhaust is seldom realized be-

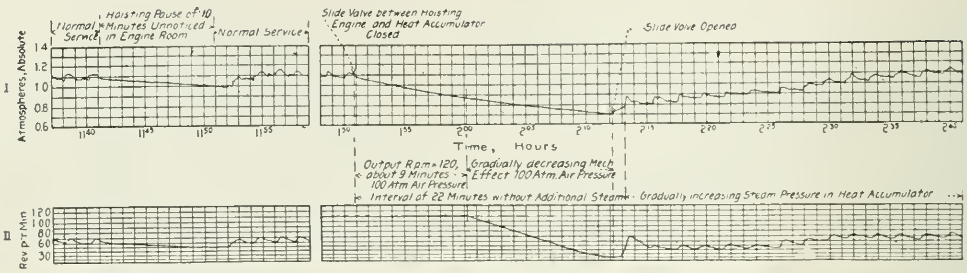


FIG. 3.

cause this engine gives considerably more steam than the compressor demands and there are comparatively few intervals in the hoisting.

The compressor is kept from running away, in the event of an increasing steam pressure, by an automatic governor valve in the passage from the accumulator to the steam cylinders. This valve throttles the steam and consequently regulates the speed of the compressor engine.

From the diagram, Fig. 3 may be seen to what extent it is possible for the compressor engine to pump out the steam from the accumulator. It will be noted that during a hoisting pause of ten minutes it would be possible for a compressor plant to double the present capacity to run without any appreciable decrease in its output.

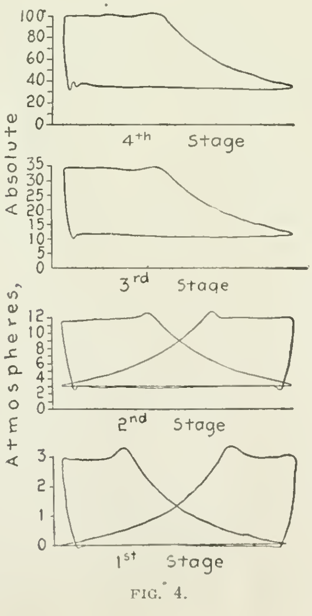


FIG. 4.

An indicator test of the compressor showed that at 120 r. p. m. there was developed in the steam cylinders 195 h. p. which compressed 406 cu. ft. of free air per minute to a pressure of 1,470 lb. per sq. in. This is shown in the indicator diagrams of Figs. 4 and 6. One set of these diagrams has been "Rankinized," Fig. 5, and shows plainly the saving effected by employing four compressor stages. The temperature of the air at delivery was 198 deg. Fahrenheit.

The economy of this installation is apparent from the following considerations: During the normal eight-hour shift, the compressor is run without the admission of any live steam; an increase of the back pressure on the hoisting engine has never been noted and the steam consumption of this engine has not been increased. Therefore, the expense of operating the compressor plant, excepting the item of attendance, is completely covered by the interest and depreciation on the cost of its installation.

The additional first cost for the exhaust-steam compressor plant as compared with an independent live-steam installation is about as follows: Steam piping, $1,199; steam accumulator, $5,236; additional cost of exhaust-steam over live-steam compressor, $1,190; share of expense for larger condenser, $3,094; total, $10,710. Thus, its yearly cost of operation is represented by the interest and depreciation on an additional investment of about $10,710. Allowing 4 per cent. for interest and 10 per cent. for depreciation, this gives:

$$\$10,710 \times .14 = \$1,500,$$

approximately, as the annual cost.

The annual cost of developing the same horsepower with electric current at $7.14 per 1000 k. w.-hours and figured on a basis of 2400 working days per years would be:

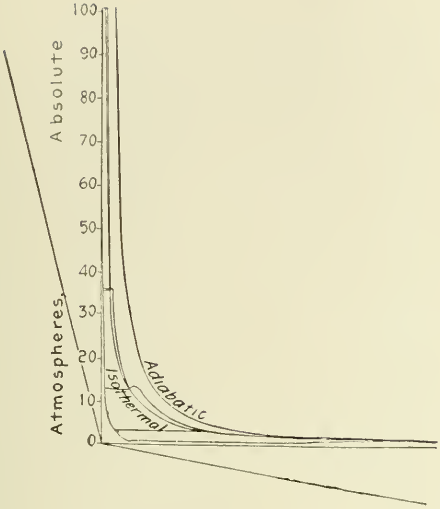


FIG. 5.

$$\frac{195 \times 745 \times 100}{91} \times 0.00714 \times 2400 = \$2741.76.$$

This is assuming an electrical efficieny of 91 per cent.

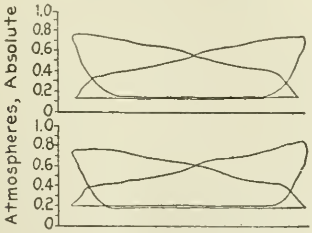
A live-steam plant with the same out-put would probably require 4840 lb. of steam per hour at 120 lb. gage pressure when operating condensing. Figuring the cost of steam at 21.6 cents per 1000 pounds, this gives 4840 × \$0.000216 × 2400 = \$2507.12 as the cost per year.

At the precent rate of hoisting, the five air locomotives perform daily, in eight hours, approximately 427 ton-miles. Allowing 300 working days to the year, the cost of per ton-mile per day is:

(1) For electrical power, \$2741.75 ÷ (300 × 427) = \$0.02142;

(2) For live-steam-power, \$2507,12 ÷ (300 × 427) = \$0.01963;

(3) For exhaust-steam power, \$1500 ÷ (300 × 427) = \$0.0117.



Normal Efficiency

FIG. 6.

This shows that the exhaust-steam power, although not as yet fully utilized, is still cheaper than either live steam or electric energy, and it is expected that this fact will be demonstrated to a much more marked degree when it is possible to run the plant at its full capacity.

OPERATION OF AIR-COMPRESSORS

BY E. A. RIX.

An air-compressor is rated by the displacement of its piston or pistons in single-stage machines, and by its low-pressure piston in two-stage or multi-stage machines. It is self-evident that this is the proper manner, although it is theoretical. Any attempt to give the actual delivery of an air-compressor would give the consideration of many factors, quite difficult to ascertain. It is right, however, for the public to know about this, for when an air-compressor seems unable to do its work or was not large enough in the first place, an intelligent idea of its deficiencies may be helpful in providing a remedy. While an air-compressor does not differ materially from a steam-engine in matters that affect its volumetric efficiency, a steam-engine which is delivering its horse-power is only criticized for its economy, while a compressor, whether economical or not, if it does not deliver the volume, is not doing its work and may therefore have to be replaced. It may be helpful to inquire into the principal things that affect volumetric efficiency, and perhaps among some of them an explanation may be found for the failure of any particular machine under consideration. Insasmuch as single-stage compressors constitute the majority of all air-compressors operated, these may be considered first, and inasmuch as the majority of air-compressors are built for and operated under 100-lb. air-pressure, investigations will be directed to that pressure. The factors affecting the volumetric efficiency are: (1) Piston and valve-pocket clearance; (2) piston and piston-rod leakage; (3) valve leakage and slip; (4) temperature; (5) piston speed.

Piston and Valve-Pocket Clearance.—When the displacement of a compressor is given in terms of the volume swept by the piston, it supposes that there is no clearance of any kind in the cylinder, and that all the air in the cylinder is forced into the receiver. This, however, cannot be done in practice, for the piston must not reach either cylinder-head by a reasonable distance demanded for safety in operation, and this varies with the character of the compressor. Few builders have less than $^1/_{16}$ in., and many ¼; an average may be safely taken as ⅛ inch.

When compressing air to a given receiver pressure, it always takes a higher pressure within the cylinder than is indicated in the air-receiver; this is due to the power required to force the air through the valve passages. At 100-lb. receiver pressure, the pressure remaining in the clearance space is at least 5 lb. greater, or 105 lb., which corresponds to eight atmospheres or eight compressions. The ⅛ in. of clearance, then, is filled with air at 105-lb. pressure. Now, when the piston begins its intake stroke it is evident that, until the compressed air in the clearance space expands to atmospheric pressure, no air can come in from the atmosphere. An eighth of an inch clearance would thus hold compressed air enough at 105 lb. to expand to one inch before any air came into the cylinder. In other words, the stroke has been actually shortened one inch. It is evident, therefore, that the shorter the stroke with the same clearance, the less the volumetric efficiency; a 16-in. stoke losing 6 per cent., an 8-in. stroke losing 12 percent., and a 4-in. stroke 24 per cent. It might not be supposed that anyone would operate a 4-in. stroke machine with any such clearance as ⅛ in., but I have seen a ⅛-in. gasket put under the heads of a 4-in. stroke compressor that already had $^1/_{16}$-in. clearance, making $^3/_{16}$-in. clearance; and this simply because a gasket of that size was on hand. It was therefore used, the result being that the compressor doctor had to be called in.

Now, in addition to the piston clearance, there are the pockets below the outlet and inlet valves that add to the other clearance. Generally speaking, this is about one-fourth of the piston clearance. Taking both these clearances into consideration and reducing them to percentage of cylinder volume, it may be said that the average single-stage compressor has clearance spaces equal to 2 per cent. of its volume. At 100-lb. receiver pressure, therefore, which calls for eight expansions in the clearance, there is a direct loss of volume by clearance of 16 per cent. in the average single-stage machine.

Piston and Piston-Rod Leakage.—No piston is ever tight in an air-compressor, even when it is new and fitted with the best of rings; neither can this be expected, for it requires gaskets and many bolts to keep a cylinder-head tight, and heavy pressure from a long wrench to make a pipe-thread tight. It is evident, therefore, that the contact the rings make with the cylinder walls is not sufficient for a joint. This can easily be tried by taking an inlet-valve out of one end of an air-compressor and an outlet-valve from the other end; admit the receiver pressure at 100 lb. into the cylinder, and the air will rush out through the inlet-valve opening in proportion to the condition of the cylinder piston and rings. Inasmuch as sometimes this becomes a great loss in an air-compressor, an operator should, upon installing a compressor, make the above test to familiarize himself with the normal leakage when the compressor is new. Then, when the machine is not delivering its proper quantity, a second test will show the difference. For this purpose I use a plug to screw into the inlet-valve opening. This plug has a round hole bored in it of such a size for any given compressor that the pressure indicated on a gauge also attached to the plug shows somewhere from 2 to 10 lb. By a reference to a "Discharge from Orifices" table, the approximate volume flowing out may be determined and recorded. If after use this machine requires overhauling, a repetition of this test will show the additional comparative loss, and thus the condition of piston and rings may be determined without removing them. Speaking of rings, it is seldom that snap rings, even with eccentric circumferences, are good enough for compressors having cylinders over 8 inches diameter. Sectional rings provided with springs are better.

The leakage around the piston-rod through the packing gland may be considerable when a compressor is carelessly operated, or it may be practically nothing with good packing, a smooth rod, and proper attention. Taking average cases, it may be assumed that there is a general loss of 3 per cent. of the volume of the cylinder due to leakage around the piston and piston-rod. In testing for such leakage the piston is placed in different positions and air under pressure that corresponds to the position of the piston is admitted, and the results are then properly averaged.

Valve Leakage and Slippage. — Poppet valves are seldom perfectly tight, and at ordinary operating speeds do not close exactly at the end of the piston stroke. All resulting leakages are against the volumetric efficiency of the compressor. In the inlet-valve comes, first, the slight slippage due to delayed closing when some of the air in the cylinder will be pushed out again; and when the valve is seated, if it is not absolutely tight, a certain quantity is being pushed out as compression progresses. In the outlet-valve the slippage and leak help fill the cylinder as the intake stroke progresses, thus reducing the intake volume. I determine these leakages in the same manner as with the piston leakage, by means of a pressure gauge and small nozzles, using the orifice discharge tables to get the quantity. In ordinary machines these valve leaks and slippages will amount to 4 per cent. of the cylinder volume. It will readily be seen that the slippage is a function of the piston speed; the greater the speed the greater the slippage, until a speed of 200 r. p. m. is attained, which is practically the limit for ordinary poppet valves. Indeed it may be less, depending on the weight of the valves. I remember trying a 10 by 10 compressor driven by a water-wheel so that any desired rate of revolution could be maintained. A hole was drilled in the side of a receiver and gauge reading taken at various speeds. At 168 r. p. m. the maximum reading was taken, and this reading was maintained up to 180 r. p. m., when the pressure fell for any increased number of revolutions. If mechanical valves had been used the revolutions could have been materially increased; just what the limit would be, I do not know.

Temperature Considerations.—These are of great importance and are extremely difficult to determine. It is evident, however, that the lower the intake temperature is, the greater the weight and consequently volume of air the compressor will deliver. It is desirable, therefore, to draw the air from the coolest place adjacent to the machine, and at the same time from a place free from fume or dust. It is also evident that the hotter the inlet-valves, the more heated the intake air becomes in passing through and over their hot surface, and the greater it will expand, thus reducing the weight taken into the cylinder and consequently the resultant volume of compressed air. The same is true of heated cylinder walls and heads. Inasmuch as water-jacketing is the only method in a single-stage compressor for reducing these temperatures, it is important to see that the water-jackets are free from sediment and that a quantity of water is passed through the jackets sufficient to show no noticeable difference of temperature in passing through. The idea is to keep a cylinder cool in order to get as great a weight of air as possible into it.

An experiment can readily be made to show this temperature influence. Drill a hole in the air-receiver and note the gauge pressure when it becomes stationary with the compressor running, then close off the jacket water and note the pressure gradually drop, showing the loss of volume. In average single-stage machins, 7 per cent. is not too much to allow for losses due to temperature influences.

Summing the losses, they are: (1) Clearance losses, 16 per cent.; (2) piston and rod losses, 3 per cent.; (3) valve leakage and slippage, 4 per cent.; (4) temperature losses, 7 per cent.; making a total of 30 per cent. In other words, the compressor gives 70 per cent. of its catalogue free-air rating, when operating at catalogue speed and 100-lb. receiver pressure. This seems quite a loss, but it is practically true, and may be considered inherent in the ordinary poppet-valve single-stage compressor. Now, if this condition exists to start with, and never grows better, but always worse by wear, it is evident that the best care and attention must be given the machine. I have noted many machines of this type that were not giving 50 per cent. volumetric efficiency from being in bad repair and unskillfully handled. It becomes evident, therefore, that if an air-compressor is not doing its work, very material gains can be made by investigating the sources of loss as herein indicated, and making necessary repairs. It is also self-evident that these losses will decrease in some ratio as the pressure decreases, and by experiment the result is about as follows:

Volumetric efficiency at 100-lb. pressure, 70 per cent.; at 80 lb., 77 per cent.; at 60 lb., 82 per cent.; at 40 lb., 85 per cent.; at 25 lb., 88 per cent. In other words, the same compressor will give 25 per cent. more air at 25 lb. than at 100-lb. receiver pressure. Now, inasmuch as 25 lb. is the working pressure of the low-pressure or intake cylinder in a two-stage machine, it needs no comment to show why it is desirable. It is also evident that a purchaser is getting 25 per cent. more for his money, independently of other gains, when buying a two-stage compressor.

While compressors are rated by displacement which does not show their true output, most pneumatic tools are very much underrated by their builders, especially pneumatic riveters, chippers, and boring machine; some as much as 50 per cent. An air-compressor need not be condemned for lack of duty, therefore, if it does not operate as many tools as rated in the catalogue.

For first aid for a crippled compressor, it may be suggested that excessive piston clearance may be remedied by putting a thin piece of boiler plate on the piston, or thin paper gaskets under the heads, if possible. Piston and rod losses point to re-boring the cylinder, to new rings, and to need of proper packing. Valve leakage demands re-grinding; valve slippage, the putting in of heavier springs and re-grinding, and, if revolutions of the compressor are excessive, these must be reduced. Temperature losses may be decreased by giving cooler inlet air, cooler jacket water or more of it, or by cleaning out the jackets. If a compressor lacks but a small percentage of furnishing air enough for its work, and the preceding suggestions have all been taken advantage of, then a "booster" consisting of a rotary blower may be attached to the suction of the compressor so as to give an intake pressur of one or two pounds, and this will materially increase the output of the compressor. Care must be taken to supply a blower having at least 15 per cent. greater capacity than the compressor.—*Mining and Scientific Press.*

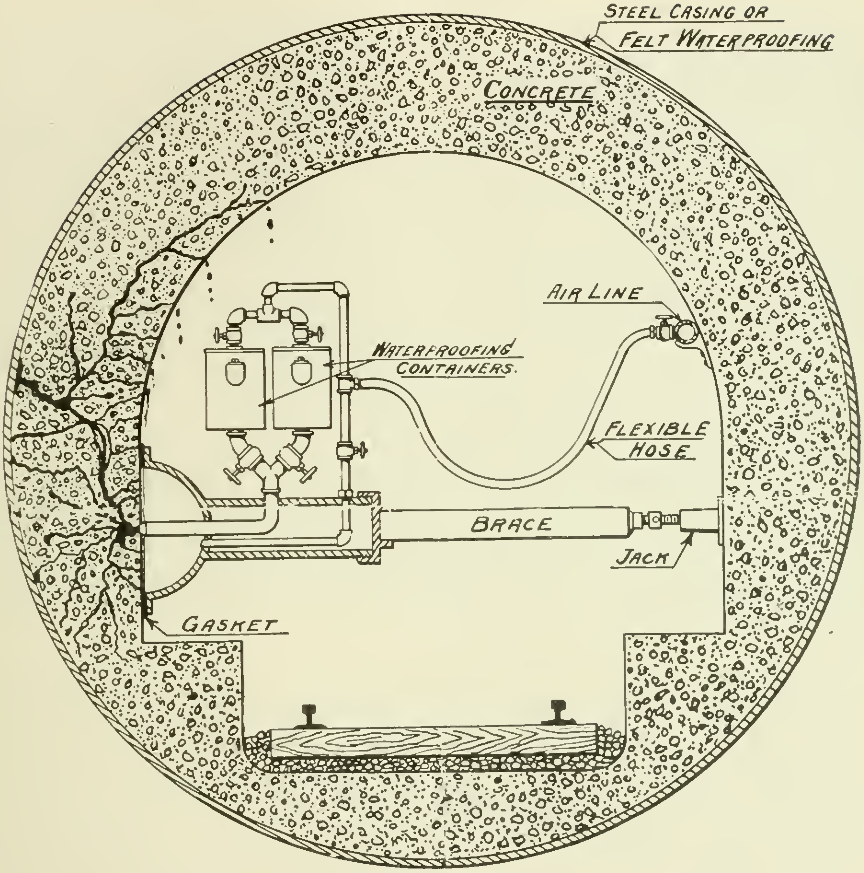
The passing winter has been so cold as to freeze up and stop the Grand Trunk Pacific passes to members of the Saskatchewan legislature.

A SCOTCH MIST ATMOSPHERE FOR SOUTH AFRICAN MINES

Consolidated Gold Fields of South Africa is really a remarkable enterprise, or, at all events, those gentlemen are remarkable who are responsible for its management. To what other body of men would it have occurred to introduce a "Scotch mist" atmosphere to purify the underground workings of the Rand mines? A Scotch mist atmosphere is to be introduced into the workings during the night, and, then, when the day shift resumes duty, a sort of heather smell will render the stopes and drives "cool and pleasant to work in." At this rate, the underground workings of the Rand mines may become a health resort, but while the Consolidated Gold Fields authorities are about it, why do they not try the effect of a London fog? This reminds us of the complaints made of the atmosphere of the Metropolitan Railway's tunnels before electrification days. A former chairman of the company was determined to stop this sort of thing and engaged a learned professor to analyse the tunnel air. But even the chairman in question felt that the professor had gone too far when he reported that the air in the tunnel at Gower street reminded him of nothing so much as that he inhaled on a Scotch moor!—*Mining World,* London.

STEEL WORKS MUST SMOKE

In an address before the Sheffield Electro-Metallurgical Society Prof. J. O. Arnold took occasion to censure the smoke-abatement movement and to point out that without smoke steel is impossible. So far as health is concerned, he said, the most mischief is caused by the household smoke, yet it is usually ignored by the smoke inspectors. Strange as it may seem, some medical men have recently taken to recommending the smoky parts of Sheffield for sufferers from asthma. Prof. Arnold asserted that in steel metallurgy smoke is absolutely necessary. Any operation that removes the carbon will produce poor steel. If a smokeless flame is used all the carbon is burnt out and the surface of the steel is made rotten. Most magistrates realize that smoke is essential to the manufacture of good steel and exempt metallurgical furnaces, but the question of mixed stacks is continually coming up to the annoyance of manufacturers.



MOORE WATERPROOFING APPLIANCE.

WATERPROOFING AGAINST PRESSURE

The accompanying sketch shows quite clearly the operation of a device which is being successfully employed for filling cracks and stopping leakages in concreted tunnels which are subject to external water pressure. Minute cracks or larger unfilled crevices extending entirely through the material seem to inevitably occur in the most carefully concreted subaqueous tunnels, these being either found at once upon the completion of the work or developing later in consequence of natural shrinkage or from the jar and strain of heavy traffic. The resulting inflow of water is a constant source of annoyance and expense, and if not quickly remedied results in delay or stoppage.

On account of the water pressure, leakage of this character can never be stopped by the application of paints or cements upon the exposed surfaces, as they are washed away as soon as applied. The water which is flowing through the cracks must first be driven back and the space it occupies must be filled with the waterproofing material, and this material must have the property of adhering where it is placed and of immediately assuming a permanent hardness, thus making it not only a filling but also a binding or strengthening material. The Mica Paint employed in connection with the apparatus has been demonstrated to completely satisfy all these requirements, and without it, or some equivalent if discovered, the operation could not be a success.

Referring to the cut, which is to be regarded as a sketch only, and not suggestive of actual dimensions or of the details of practical application, a large cast iron bowl is placed over the crevice to be stopped and made as air-tight as possible by a thick, yielding gasket against the cement surface, with the brace and screwjack behind it to resist the pressure. Compressed air is then turned on sufficient to drive back the water, and the mica paint is then admitted to the bowl and, backed by the air pressure, is driven in to fill the cracks. When one crack, or a portion of it, has thus been treated the bowl or air tight chamber is placed to cover another crack, and so on until all the leakage has been permanently cured.

This is beyond the stage of experiment and is a demonstrated success, having been employed upon the Hudson River tunnels of the Pennsylvania Railroad and elsewhere with most satisfactory results. The operation as described seems simple enough, but in the practical employment of it of course judgment and experience count for much, and especially does the success of it depend upon the use of a filling material which completely satisfies the imperative rquirements. The Mica paint, as a paint, has been thoroughly tried by the paint experts of the New York Central, Baltimore & Ohio, Pennsylvania Railroad and the American Car & Foundry Company for steel cars. Both the apparatus and the paint are controlled by The Mica Paint Company, 76 William Sstreet, New York.

AIR BLAST FOR CHILLS IN FOUNDRY

Details have recently been made public of a new method of making chilled rolls for sheet and tin plate mills, in which the chilling is done by air blast instead of by water. The chilling section of the mold is surrounded by a drum having a spiral internal fin. Air under pressure is fed into this drum and, after circulating in a spiral course around the mold, is exhausted to the atmosphere. The mold is ribbed, radiator fashion, to facilitate cooling. The operator can control the cooling effect at will by manipulating a gate valve where the blast enters the mold, and a thermometer fixed in the flow of the blast as it leaves the drum indicates exactly how the cooling is proceeding. It is claimed that the process not only produces a perfectly even chill, but a surface is given to a sheet or tin plate roll which is practically the same as that given by the water-chilling process and without the risk of internal stresses in the metal. The time of cooling is absolutely within the power of the operator, so that the metal can be set rapidly to get the necessary polish for the face and then the body be cooled gradually to eliminate the casting stresses. Other advantages claimed are simplicity, an even depth of chill, and the absence of wave marks on the finished sheets.

It is not generally known that in many of the bituminous mining districts of this country fully 50 per cent. of the coal in an acre is left in the ground, with no possible hope of ever being recovered.

The largest coal contract ever awarded an operator in the Virginia field has been given the Virginia Iron, Coal & Coke Co. by the Boston and Maine railroad. It is the railroad's coal contract for five years, and involves nearly $10,000,000.

In the Canal zone the following warning notice has been posted: "Alcohol, gasoline, benzine, naptha or kerosene are easily ignited. They must be kept in a cool, well ventilated place, remote from lights or fires. Lamps or burners must never be filled while lighted. The pouring of any of these fluids on a lighted fire or live coals, or on inflammable substances which it is the purpose to ignite, is dangerous to life and is absolutely prohibited."

NEW YORK FOUNDATION METHODS FOR MICHIGAN MINE SHAFTS

BY P. B. MC DONALD.

The sinking of concrete drop-shafts, using compressed air for holding back water and quicksand, was introduced by the Cleveland-Cliffs Iron Co., some four years ago, for several shafts on the Swanzy range south of Negaunee, Michigan. Attention has been attracted to the process by the success attained by its use in bridge-pier and tunnel work. The method has since been utilized a number of times, both on the Michigan and Minnesota ranges, and its adoption has followed the growing tendency toward exploration of deep, drift-covered deposits by churn and diamond-drilling. Ore-bodies discovered under heavy overburden by drilling, demand permanent,

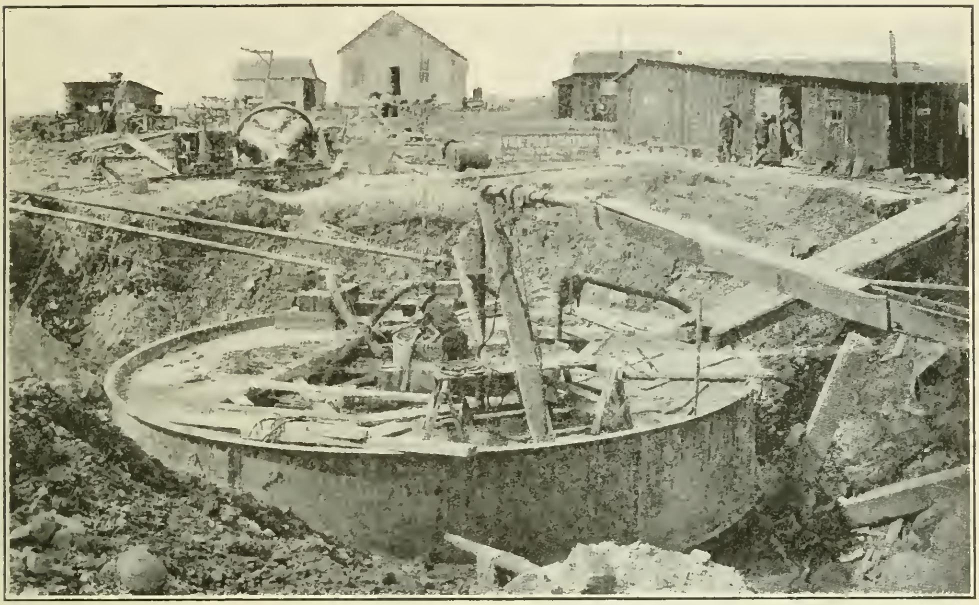


FIG. 1.

water-tight shafts for hoisting purposes, and the recent impetus given to diamond-drilling has encouraged the practice of sinking concrete shafts.

The Munro Iron Mining Co. had proved a large orebody by diamond-drilling at the Rogers mine, four miles east of Iron River, and it was desired to sink a shaft in the foot-wall through 140 ft. of glacial gravel, sand, quicksand, and boulders. None of the operating mines of the district are within three miles of the site chosen, so that the overburden gave promise of containing considerable water, especially as a swamp overlies a portion of the orebody.

A timber shaft might have been attempted, but it was known that a mine nearby had been trying to put down a timber shaft for over a year and was finding it difficult. Also, when finished, a timber shaft would let in a large quantity of water and might give trouble as to keeping it plumb. Thus the Maas timber shaft on the Marquette range got out of line so badly, and let in so much water, that after several years' use it was filled with sand and a large concrete shaft was sunk around it. Teal lake, not far distant, from which the city of Negaunee gets it water supply, had begun to lower materially, so that it was thought the lake was draining into the Maas mine. Since the concrete shaft was finished the level of the lake has risen.

It is to be understood that it is the thick overburden, with its tendency to shift and conduct large quantities of water, that presents the most difficult part of sinking and maintaining shafts in the Lake Superior region. The portion of a shaft which is in solid rock makes comparatively easy sinking as compared with work in wet soil, where the excavation is constantly getting out of plumb, and water and quicksand come in in such quantity as sometimes to compel abandonment of the work.

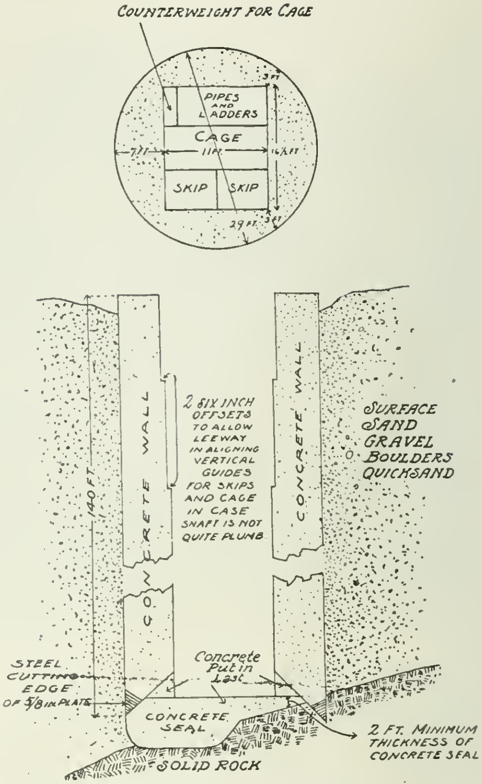
For this reason a concrete shaft is very satisfactory in such a place if the ore-body warrants the initial cost. The Roger's shaft here spoken of cost approximately $500 per foot; a timber shaft might have been cheaper, or it might have cost more.

The work of sinking the concrete drop-shaft through the 140 feet of overburden was undertaken by the Foundation Company of New York. Work was begun about the middle of February, 1911, and the drop-shaft was sealed to the rock about the middle of July. Three months of the time was spent on the first 125 ft., during which no compressed air was used, and two months on the last 15 ft., with compressed air at a pressure of from 38 to 45 pounds per square inch as the sinking reached the rock. In the heaviest pressures each man worked two 40 minute shifts per 24 hours and received $4 per day.

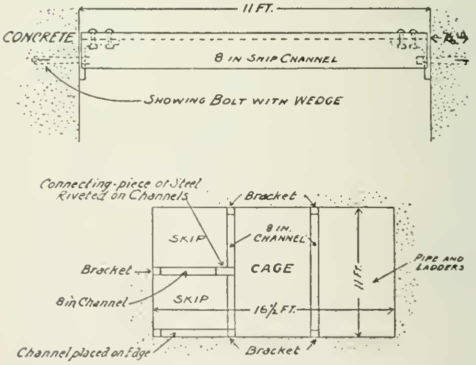
The first stage of the work, with no compressed air, went along rapidly and consisted simply of dredging dirt with a clam-shell and derrick from the interior of the shaft, so that the concrete casing sank by its own weight, more concrete being added at the surface in 5 ft. sections as needed. During these three months the shaft was kept full of water (to the level of ground-water, about 30 ft. from the surface) which helped work the dirt from under the cutting edge of the casing, so that the clam-shells could work to better advantage. The bottom or cutting edge of the shaft was sharply beveled and encased in a steel plate for the better forcing of its way through the overburden. The weight of the heavy concrete walls was sufficient to drive the shaft down as the earth was dredged out from the interior. Vertical and horizontal reinforcements were used in the concrete, both of 1 in. steel, and placed near the outside and inside edges, about 18 in. apart.

The second stage of the work, with compressed air, held in the shaft by a 6 ft. timber and concrete deck placed across the opening, was made necessary because boulders and hardpan were encountered, requiring men to work with pick and shovel under the cutting edge. The deck was set in notches left in the concrete, and the men and earth were "locked" in and out through a cylindrical steel chamber placed over a hole cut in the deck. Men used to this special work were brought in, about half of whom were negroes. It was estimated that the lifting pressure under the deck was about 700 tons. The deck and air lock were put in with considerable care and an air compressor of reliable type, the so-called *Hurrican Inlet* pattern was adopted.

When the rock was reached it was necessary to cut out the soft, oxidized upper layer in order to seal the shaft to hard, compact rock. When this was finally done the Foundation Company's contract was finished and the air pressure was taken off. The shaft had to be delivered by them water-tight, ready for the mining company to begin sinking with rock drills, and unless the bottom had been properly sealed to firm foundation the shaft would not be water tight in the bottom. No water had been pumped, so that the level of ground-water of the surrounding country was unchanged, and about 100 ft. head of water was on the shaft. In this respect the method


COUNTERWEIGHT FOR CAGE
PIPES AND LADDERS
CAGE
11 FT.
7 FT.
16½ FT.
SKIP
SKIP
29 FT.
3 FT.
2 SIX INCH OFFSETS TO ALLOW LEEWAY IN ALIGNING VERTICAL GUIDES FOR SKIPS AND CAGE IN CASE SHAFT IS NOT QUITE PLUMB
CONCRETE WALL
140 FT.
SURFACE SAND GRAVEL BOULDERS QUICKSAND
STEEL CUTTING EDGE OF ⅝ IN. PLATE
Concrete Put in Last
CONCRETE SEAL
SOLID ROCK
2 FT. MINIMUM THICKNESS OF CONCRETE SEAL

PLAN AND SECTION OF DROP-SHAFT.



CROSS-SECTION OF SHAFT. DIVIDER SHOWN ABOVE.

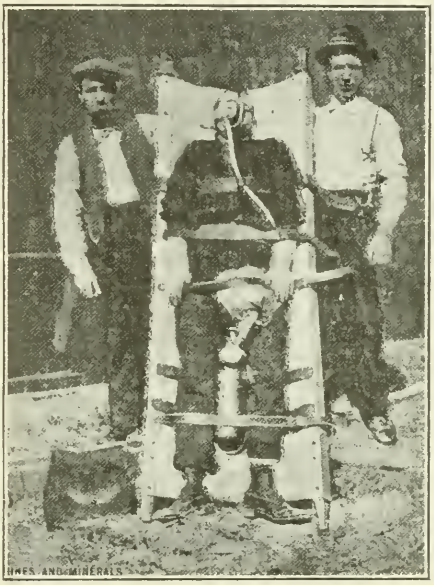
FIG. 2.

is markedly different from ordinary sinking, in which the level of ground-water is lowered by the pumping necessary to enable men to work in the shaft. With the compressed-air method, instead of seeking to drain the surrounding country and lower the level of ground-water, the water is held back by air of a pressure in pounds per square inch approximately of one-half the number of feet head of water outside. When the casing has been bottomed in solid ground and sinking in rock is commenced, the water can be pumped to better advantage, as it cannot come in so fast. However, the soft rock must be removed from the rock surface while the air is still on, or otherwise the miners will be drowned out by a rush of water when drilling is commenced in rock.

Putting in the steel dividers after the casing had been sealed to rock was a job requiring careful attention. In the first place, despite the two 6-in. offsets, one wall of the shaft had to be chipped off considerably to use 8-in. ship channels for drivers and to support them on steel brackets. To fasten the brackets to the walls, two holes were drilled with an air-hammer drill and the bracket bolted with two bolts, which were driven in on wedges to expand their ends; melted lead was then poured into the holes to make a firm joint. Condensed from *Mining and Scientific Press.*

DUST EXPLOSIONS

While powdered coal has almost alone been the subject of recent investigations, it cannot be too plainly insisted upon that all finely divided, highly carbonaceous material possesses dangerously explosive potentialities. In May, 1878, a tremendous explosion occured in the Washburn Flour Mills at Minneapolis. The building was completely wrecked. Subsequent investigation led to the opinion that the flour dust was the primary cause of the disaster. Some time ago a similar explosion occurred in a Manchester starch factory. On the 10th of last November an explosion occurred in Messrs. Primrose's flour mills at Glasgow, as a result of which five persons were killed and eight injured. At the inquiry held on the disaster it was stated that there was evidence to show that the explosion had been due to the ignition of meal dust by a naked Bunsen burner. It appears that at half-past five each night it was customary to sweep up the accumulation of dust from the floors. The explosion occurred at half-past six. It should also be recorded that at the inquest held in connection with the explosion which occurred at Messrs. Bibby's oil cake mill at Liverpool on November 24th, it was stated that tests showed the dust in the mill to be equally, if not more, explosive than coal dust.



OXYGEN STRETCHER

In rescue work after a coal-mine explosion it not infrequently happens that a man is found, unconscious but still breathing, beyond a stretch of bad air. Could the man so overcome be safely brought to daylight, in many cases his life might be saved by the application of a pulmotor, or some similar device. In order to carry a helpless patient through bad air D. H. Reese, foreman in charge of the instruction car of the Victor-American Fuel Co., Hastings, Colo., uses a combination of an ordinary stretcher with the standard form of oxygen apparatus which has proved very effective whenever tried.

The outfit consists of a stretcher of extra heavy canvas to which is fastened a complete set of Westphalia oxygen apparatus, in the position shown in the half-tone here reproduced from *Mines and Minerals.* The oxygen tank rests in a steel bracket fastened to the bottom of the stretcher, and when empty may be replaced in a few seconds. The indicator, reducing valve, breathing bag, hose, etc., are all of the standard pattern and interchangeable with similar parts used by the regular rescue crews. The face mask is fastened on with double straps. It will be noted that straps are provided to securely fasten the patient upon the stretcher in event of his having to be carried over falls or the apparatus has to be "up ended" when placed on a cage. The breast strap is 3 feet long and 2 inches wide; that over the hands, 5 feet long and 1 inch wide, and the abdominal and leg straps each 3 feet long and 1 inch wide.

In actual practice it is found possible to have an unconscious patient breathing oxygen within 1 minute of his discovery, and strapped upon the stretcher within 4 minutes more. The entire apparatus as used by Mr. Reese weighs 42 pounds.

GAS FOR MELTING GOLD AND SILVER

As a result of experiments which have been made since 1909, the British Royal mint has adopted gas as a fuel for its melting furnaces. The adoption of gas as a fuel in place of coke has been accompanied by several incidental economies. The charge for fuel averages about 4½d per hundredweight of standard gold bullion as against 9d when coke was used. The fuel needed to warm up the furnace in the morning has been eliminated; but, including this, the cost rarely exceeds 5d per hundredweight on a day's work. During 1910 the mint installed sixteen gas-heated furnaces, each capable of taking a 400-pound crucible. These 16 crucibles have a maximum capacity of 2¾ tons of silver, or 2¼ tons of bronze per melt. Five furnaces similarly gas-heated, but of smaller size, are used for melting gold. The expenditure on crucibles, which is a large item, has been reduced by 33 per cent.

TESTING CYLINDER OILS

1. Saponification test. 2. To ascertain if there is any free sulphuric acid in mineral oil. 3. Flash tests. 4. Burning test. 5. Precipitation test. 6. Congealing test. 7. Test for acids. 8. Test for alkalies. 9. For viscosity.

1. Place a small quantity of the oil in a pan of some kind, and put into the oil about 2 ounces of concentrated lye. Boil the oil for about 30 minutes and then let it cool off. After the oil is cool examine the surface, and if it is covered with a soapy substance it contains fatty matter. If the surface is clear, it is mineral oil unadulterated.

2. Take a small quantity of the oil to be tested and heat it in a pan or other convenient vessel, to about 300 deg. F. Let it stand for a few minutes, and then let it cool off. If the oil is darker in color than before boiling, it is fair to assume that there is sulphuric acid in it. Oil containing sulphuric acid should not be used for lubricating the internal parts of steam cylinders and valves.

3. Heat a small quantity of oil in a vessel to about 300 deg. F., to begin with. Light a piece of stick and pass it over the surface of the oil, back and forth, until the vapor from the oil takes fire with a flash, the temperature at which flash occurs is called the flashing point.

4. Continue to heat the oil until a lighted stick passed over the surface causes it to burn, the burning point is then reached, the temperature being indicated by the thermometer.

5. Place about an ounce of oil in a bottle, say of about ½ pint capacity. Then pour in about 2 ounces of gasoline. Shake up the oil and gasoline thoroughly, and allow the bottle to stand long enough for the contents to settle. If there is any sediment in the bottle, the oil has been doctored.

6. Pour out some oil in a pan, and place the pan in a quantity of ice to which salt has been added. Cover the pan with something to exclude the warm air of the room. In a short time the oil will congeal; next surround the pan of oil with boiling hot water, until the oil begins to melt, at which time the immersion of a thermometer will indicate the congealing point of that particular sample of oil.

7-8. Take a small quantity of oil and place in a vessel of boiling water, say about an ounce of oil to six times its volume of water. Also steep in the water a piece of red litmus paper. After the whole has soaked for a while, if the litmus paper remains red, the oil contains acid. If the paper turns to full blue, the oil is alkali. If the color of the paper changes slowly to a light blue, the oil is neutral.

9. Take a sheet of glass and make an inclined plane of it by blocking up one end. Place a drop of several oils at the top edge of the glass, and note just how fast each drop runs down the plane toward the bottom. That which gets to the bottom last, is the highest in viscosity.—*Practical Engineer.*

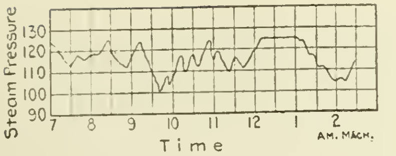


FIG. 1

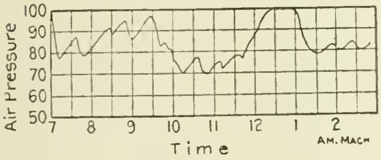


FIG. 2

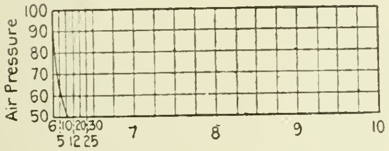


FIG. 3

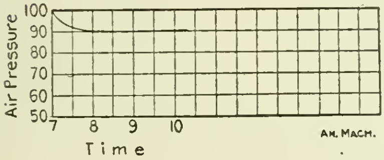


FIG. 4

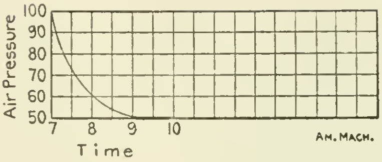


FIG. 5

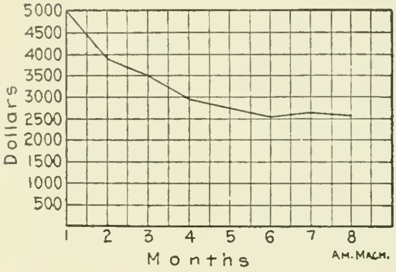


FIG. 6

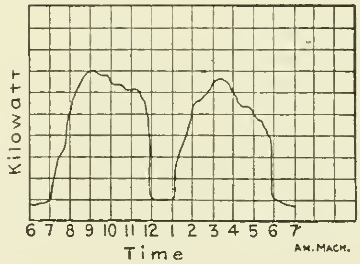


FIG. 7

LOCATING AND CORRECTING POWER PLANT INEFFICIENCIES*

BY C. J. MORRISON.

In an ordinary shop of the present day the arteries, as you may call them, carry steam, compressed air, water and electricity. Recording gages, placed on these arteries, will reveal an interesting story. In one shop the records showed immediately that the variations at the power house materially reduced the efficiency of the plant and, at the same time, gave the information that the machines were not producing the maximum possible output.

The steam gage gave an average record, as shown in Fig. 1. The air record was even worse, as revealed by Fig. 2. With all valves closed and the compressors shut down, the record in Fig 3 was obtained. With all valves closed and one compressor, which gave one-third of the total capacity, running at full speed, Fig 4 was recorded.

Translated: One-third of the entire power of the compressors was being exerted to hold a 90-lb. pressure against leaks in the line. A still further loss was due to moisture in the air. The installation of cooling and reheating tanks and the appointment of a man to stop the leaks, soon overcame the difficulty with the air, so that a month later Fig. 5 was obtained, with all valves closed and the compressors shut down.

The air-trouble man was paid a bonus, depending on the leakage, and soon got the pipes in such condition that the pressure did not drop below 50 lb. at the end of a five-hour shutdown. As the fluctuations in steam pressure were felt to be at the bottom of the difficulty, steps were taken to effect a cure. An automatic draft regulator was installed, and a change made in the grates. These improve-

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*Condensed from *American Machinist.*

ments not only gave a steady steam pressure, but reduced the power-plant expenses, as shown in Fig. 6.

The consumption of electric power for the entire shop, revealing a low efficiency, is shown in Fig. 7. It was at once evident that many of the machines were not started until long after the starting time, and also that many were stopped before time. These records were obtained for each department, and the superintendent went vigorously to work to secure square records. Any foreman whose department was not producing a square record was called upon for an explanation, with the result that at the end of the second month the plant was showing a 10 per cent. increase in output.

This desirable result was obtained with no change in, or disruption of the organization, and the money expended was almost immediately returned by the reduction in power-plant expenses.

CHEAP AND EFFICIENT WATER COOLING

The illustrations here reproduced from *Gas and Oil Power,* London, show us the Tattersall patent rapid, multiple effect water cooler, made by C. Whittaker & Co., Haslingden, England. Its action is based upon two familiar facts which science has established. The first is that when water is evaporated a large amount of heat is absorbed by the water vapor and becomes latent, this latent heat being absorbed from the water, and the matter with which the water is in contact, and cooling it to that extent. When 1 lb. of water at 60 degrees Fahr. is evaporated, approximately 1,100 British thermal units are absorbed, in this case from the rotary evaporators, cooling them and the air. The second fact is that the higher the temperature of the air and the lower its degree of saturation, the greater is its power of evaporation.

In this cooler advantage is taken of these facts to the fullest extent, which enables it to evaporate a much larger quantity of water and to produce a greater cooling effect than other coolers which operate only with air at normal temperatures and discharge it cold and more or less saturated.

The cooler occupies small space and requires little power to drive it. It consists essentially of a series of rotary evaporators formed of a large number of short tubes of small diameter, each of which carries up a definite quantity of water which is evaporated by the air passed through and between the tubes. The lower parts of these evaporators pass through a tank containing the water to be cooled, and from this they continually abstract heat. There are two radiator batteries of high efficiency formed of flat tubes arranged one above the other, through the tubes of which the water to be cooled successively passes before entering the tank, and between the tubes of which a current of air passes, thus securing a transference of heat between the two whereby the water is cooled and the air heated. Other parts of the cooler include a fan to produce the current of air, a pump to circulate the water to be cooled, a ball tap to admit water to make up for that carried off in the air by evaporation; the necessary cas-

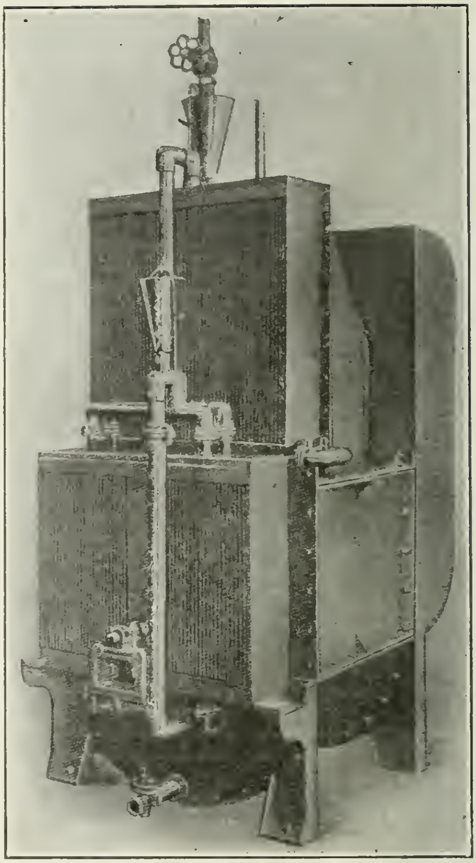
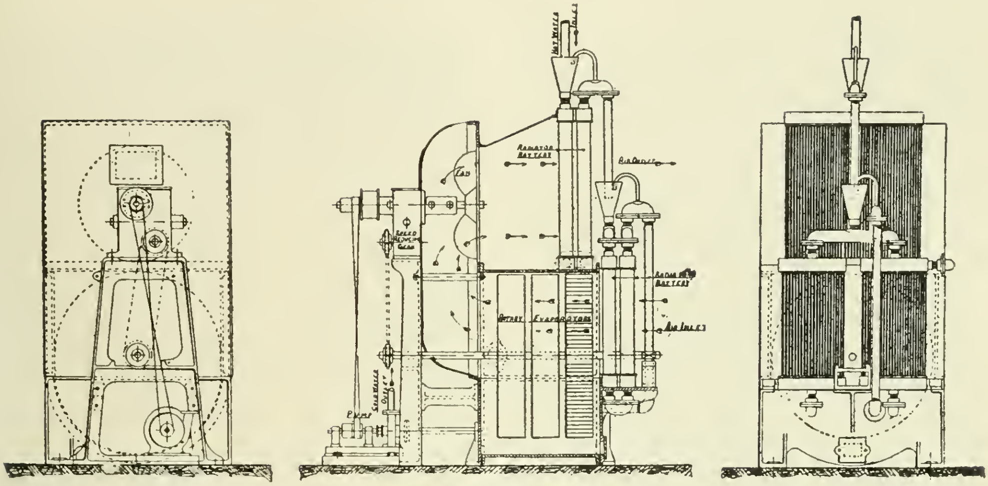


FIG. 1.



—View of Driving End— —Longitudinal Vertical Section— —View of Radiator End—

FIG. 2.

ings and supports, and the driving arrangement.

In operation the fan draws air, as indicated by the arrows, through the bottom radiator battery, where it cools the water passing through the battery, and becomes heated, whereby it is enabled to absorb and evaporate a much greater quantity of water from the rotary evaporators through which it next passes; in doing which it cools the evaporators and is itself cooled, and is then forced by the fan through the top radiator battery, where it absorbs heat from the water passing through and becomes heated, in which state it is discharged from the apparatus. It will thus be seen that the water passed through this cooler gets a triple cooling effect, viz.:—first, in the top battery, and, secondly, in the bottom battery, thus receiving a preliminary cooling before reaching the tank which it enters at a greatly reduced temperature, one effect of which is to prevent vapour being given off. The third and final cooling is in the tank by means of the rotary evaporators, as explained previously. No water or vapour is carried out into the air and wasted, only hot dry air being discharged, and this, of course, itself may be used for ventilating or drying.

We are informed that practical results bear out the theoretical economies claimed. In use a cooler of the type illustrated, the overall dimensions of which are 6 ft. long, 3 ft. 6 ins. wide, and 6 ft. 6 ins. high, passed 4,000 lbs. (= 400 gallons) of water per hour, and reduced the temperature from 134 degrees Fahr. to 78 degrees Fahr. = 56 degrees Fahr., which equals a cooling effect of 224,000 B. T. U., and assuming that in a gas or oil engine each H. P. requires 3 gallons per hour to cool the circulating water from, say 120 degrees to 80 degrees Fahr. = 40 degrees Fahr., then this plant would cool an engine of 250 H. P. In this case the tests were made during January, 1912, under very bad conditions, the temperature of the air before entering the cooler being 58 degrees Fahr. dry bulb, and 56 degrees Fahr. wet bulb, the saturation being 87 per cent., and the evaporative efficiency of the air only .7 of a grain of water per cubic foot of air. The air left the cooler at 87 degrees Fahr. dry bulb, and 76 per cent. Fahr. wet bulb, the saturation being 55 per cent. The power to drive the cooler was slightly over 2 H. P., or less than 1 per cent. of the engine power.

THE ANTETYPE OF THE ROCK DRILL

The first and most perfect drill instrument of its kind is still in use. In fact, more of these drills are used than of all other makes put together. The drill has few parts and the simplicity of its mechanism is one of its advantages. Its main feature consists of three long pieces which are dovetailed one with another, and glide easily through their entire length, the boring being accomplished by the alternate gouging of the chiseled tips. Two of these parts act as guides which close about the drill proper. This drill is not adapted for work in hard material but for all that those who have used it prefer it to any other type on the market. This drill is controlled by a bug, whose nickname is *Thalessa Lunator*, or in plain United States, the great ichneumon fly. Its boring mechanism is said to have furnished the idea for the modern rock drill.

REDUCING THE DANGER OF SEA DIVING

The writer had an opportunity to view the harbor improvements some years ago in an Australasian port. The diver came up before his usual time, and brought with him an octopus that must have measured a good ten or twelve feet from tip to tip of tentacles. It was clinging to his back, twined round all his limbs, but fortunately had not anchored itself to any of the rocks or piles. The beast objected to his atmospheric bath and slid back into the sea through a two inch gap between the planks of the wharf.

Dangers of this kind are inevitable to the diver's art, but much has been done of late years to protect him from perils of faulty apparatus and inefficient means of communication. A number of these improvements are due to Messrs. C. E. Heinke & Co., of London. The pumps, dress, helmet and boots have all received attention.

Slight improvements have been made from time to time until the aggregate of changes has become very considerable. The old style diving dress was by no means a comfortable garment. The seams at the feet and neck leaked; the pressure of the wrist outlets numbed the hands; the cut of the sleeves prevented the hands being brought together at the front without great discomfort and chafing. It has at length been found how to make a foot with but one seam, how to form a watertight cuff without undue pressure, and how to reinforce seams without making the dress unwieldy and stiff. The latest pattern of boot consists of a solid brass casting for protection to the foot. An ingenious arrangement of straps prevents the foot being accidently withdrawn. Every detail of the equipment has received the same minute care.

For light, the diver is offered his choice of oil or electric lamps. The former is supplied with air through a branch hose from the air pump. The latter are fed by a special robust flexible cable. For communicating with the attendants above, there is a patent speaking apparatus that depends for its action on an extra air tube, fitted with sound discs in the diver's helmet. A more elaborate device consists of a telephone adapted for submarine work. Transmitter and receiver are suitably placed inside the helmet, and a call button operated by the diver's chin. The conductors can be embedded in the rubber wall of the air tube or in the life line. The equipment for the use of two divers working together makes provision for communication between them as well as to those on boat or land.

The uses to which this apparatus has been put form a romance in themselves. When the S. S. "Japan" was burned the first Heinke suit ordered was lost in a wreck. Another was then sent out, the first was recovered by its use, and both were then successfully employed to salve £77,000 worth of gold and silver coin in fused masses. Seven of the most celebrated divers have, by the use of this apparatus, salved between them over £10,000,000 of bullion and over 100 vessels. Another curious case was the recovery of a chased silver hunting knife valued at £7,000. This was recovered from the S. S. "Cadiz," wrecked off Ushant, after two months submersion.

In pearling, naked diving is being fast replaced by diving with apparatus, and it speaks well for the manufacturers that a round thousand of Heinke outfits are in daily use by semi-savage operators.

Homelier uses for this apparatus are found in dock and harbor constructions, dock working and maintenance, emergency ship repairs and a hundred and one other branches of the marine industry. For all purposes, over seven hundred equipments are turned out yearly.—*Far Eastern Review.*

Hammer drills are used near Atlin, British Columbia, in breaking lumps of frozen gravel. The bit used is sharpened as is a moil, and cuts into the clay and gravel quickly. The vibration of the drill seems to shatter the material and, by prying a little, lumps as much as ten feet in diameter can be broken.

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MAGAZINE

EVERYTHING PNEUMATIC

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THE STORM KING WATER TUNNEL

The "holing through" of the Storm King tunnel under the Hudson, which was accomplished on Jan. 30, was recognized by the engineering world, by the residents of New York City and by the general public as an event of the greatest importance, and it was celebrated with all the ceremony which circumstances at the time permitted. A party of eminent engineers, of New York City officials and others were conveyed by special train, and after they were lowered to the bottom of the east shaft Mayor Gaynor closed a switch which fired the final blast that brought the advance headings from the opposite shores together. Then the party walked through the tunnel to the point of junction, speeches of congratulation were made and toasts were drunk according to time honored custom.

This is one of the most important and responsible bits of tunnel work that has ever been executed. It runs practically level between the shafts on each side of the river 1,200 feet below the water, making it by far the deepest water tunnel in the world. When the great aqueduct was being planned to convey a sufficient supply of water from the Catskill Mountains to the Metropolis the most difficult detail to determine was the crossing under the Hudson. When the location was decided upon unexpected difficulties developed from the unsoundness of the rock which the borings revealed, and it took some years of ingenious and persistent piercing of the rock to great depths before assurance could be given that the material to be encountered would be safe to drive the tunnel through. The result has fully corroborated the assurance given by the preliminary investigations, so that the rock actually encountered was exceptionally sound and free from water and the tunnel was finally driven in almost record time.

With this tunnel under the Hudson now assured the date of completion of the entire work can be promised with practical certainty, and it will be permissible to speak of the great undertaking as a whole. It is not only one of the world's great engineering achievements, but it is a great historical event as well, touching the lives and habits of millions of people and compelling comparison with the aqueducts of Rome in her glory.

The great need of the ancient city, as of the modern, was a copious and reliable supply of water. Water is generally abundant if we seek far enough for it, and the problem has been in either case simply to collect and store and deliver it where and when required, and for this the highest engineering talent of either age has been employed. The remains of the ancient works show the limitations as well as the constructive ability of the age. The engineer necessarily planned according to his means of execution. He had not the high explosives and he had not learned to use compressed air, either for operating his rock piercing and cutting tools or for resisting water pressures when encountered, and so he could not burrow deep into the rocks and his aqueducts were necessarily built as artificial rivers giving the water an easy, open flow for whatever distances might be required. To cross the valleys some monumental and enduring structures were erected which are architectural wonders to the present day.

The pressure aqueduct of the moderns has nothing for the eye, but it serves its purpose most effectively and is in nothing perhaps more astonishing than in the rapidity with which it can be constructed from beginning to end. The greatest engineering works of recent years all on the American continent, have been the Panama Canal, the New York State Barge Canal and the Catskill Aqeduct. The latter, the latest to be planned, will be the first to be completed and put into full service. It is completely indebted to Compressed Air for its existence and could not have been built, could not have been planned or thought of, without it. There are therefore none who can more properly exult in the successful completion of the work than Compressed Air Magazine.

THE STORM KING TUNNELING RECORD

A remarkable speed record was made in the driving of the Storm King tunnel, although the conditions under which the work was done necessarily bar comparison with other tunneling records. All the material handled had to be hoisted through shafts on either side of the river 1,100 feet deep. The tunnel was driven all the way through hard granite to a clear diameter of 17 feet. This is to be lined with concrete, leaving a smooth finished interior 14 ft. 6 in. diameter.

The shafts had been sunk on each side of the river and about 200 feet of the tunnel had been driven at one end when, in June, 1911, the contract for the completion of the tunnel was let to the T. A. Gillespie Company, with the date of April, 1913, assigned for the completion of the work, including the concreting of the entire tunnel and the shafts. From the beginning of the work under this contract until the meeting of the headings on January 30, 1911, over 2,500 feet of tunnel was driven at an average rate for the two headings of over 360 feet per month. On the heading driven from the west shaft there was maintained an average rate of progress of 265 feet per month for the distance driven of 1,744 feet.

FASHIONS IN TOOLS

There is a tyranny of fashion to which we are all subject in the texture, the cut and color of our garments, and, except for the changes which are made in recognition of the temperature conditions of the successive seasons, there would seem to be little more than an initiative caprice and then the imitative habit to account for them. There are changes of fashion also in our tools, in our ways and means of doing work, and for these it is to be hoped that more rational and satisfactory explanations may be found.

For one thing, it is to be expected that the changes of fashion in our tools shall lead to better work or more easy and prolific accomplishment, and this expectation we are seeing constantly realized. Perhaps one of the most pronounced changes of fashion in our tools is occurring or has occurred, we may say, within the century which is still young, and in one of the most strenuous and exacting of our industries. We have to recognize the fact that in certain lines of rock drilling the hammer drill is becoming the fashion, and the percussion drill is no longer sure of universal employment. This changing fashion is not born of caprice nor extended by servile imitation, but is dictated by judgment and experience and endorsed by practical results.

The change of fashion from the percussion drill to the hammer drill is, as often happens with all our fashions, not the exploiting of a novelty but a reversion to the fashion which prevailed long ago. The hammer drill works upon the same principle as the hand drill, while the reciprocating bit-carrying piston was a distinct and radical departure in mode of operation from the hand-held sledge-driven drill which it displaced, and in results accomplished so greatly excelled. It would seem now that the persistent success of the reciprocating drill is to be attributed to other features and accompaniments rather than to the reciprocating principle in itself.

Indeed, it is not easy to understand why the inventors of the first power rock drills did not imitate the hand drill operation. The hammer drill does. The bit is pressed tightly and constantly against the rock and the hammer blows are showered upon it with a sharpness and rapidity little to be compared with the thud, thud of the heavy piston-carried bit. No matter how deep may be the hole, within the working limits of the drill, or how much the hole may be choked by the accumulation of mud, the stroke of the hammer is just as sharp and quick at all times, which is very different from the operating action and effect of the reciprocating bit.

The discarding of cumbrous appurtenances, the lightness of the hammer drill itself and the means of placing it and holding it to its work, as compared with its predecessor, give it perhaps its greatest advantage when it comes to counting up the work done and the cost of it.

It is, in the first place, a one-man instead of a two-man or a three-man drill. It dispenses with the tripod and the heavy weights to hold it down, and it has as little use for the column or bar with their jack screws to be so carefully set up and so constantly watched. The drill is just lifted to the required position and then a puff of air not only holds it securely but also does the feeding when in operation. The drill, therefore, like the express train, makes much of its gains by shortening its stops and keeping more constantly at it.

We must keep up with the fashions in dress, or life is not worth living, and in the competitions of business following the tool fashions is still more imperative, for without them progress ceases and success departs. The fashions in either line rarely originate with those who follow or adopt them. Those who originate the tool fashions have great responsibilities, and they only hold their own by keeping always in the lead.

AVIATION AND ARTERIAL PRESSURE

The constantly increasing application of the aeroplane to such practical uses as cross-country flying, and delivery of letters and parcels, the location of submarine boats and mines by reconnoitering above the water (a feat recently successfully accomplished in France), and the carrying of passengers, directs attention anew to the importance to the aviator of an exact knowledge of the powers and the limitations of his own body. Marvelous as is the human machine in its powers of recuperation after injury or strain, it has the disadvantage that it cannot be reassembled when once shattered, and worn-out portions cannot be replaced by new ones ordered from a factory—facts that reckless young aviators are apt to ignore.

Of especial importance is it to the aviator to know the condition and capacity of his heart and arteries, because of the severe strain put on them by the rapidity of movement, the fluctuations of air-pressure, the concentration of attention demanded, and the ever possible violent excitement of sudden danger. If "the motor is the heart of the flying-machine," the heart is the motor of the human machine, and in either case a defective motor is the gravest source of catastrophe.

Altitude flying has a peculiarly disturbing effect on the heart, not only because of its intimate association and co-operation with the lungs, but because of the variations in arterial pressure produced by changes in the density of the atmosphere, and the fact that the tremendous rapidity of ascent and descent does not afford time for the proper adjustment of the internal to the external pressure. It has been said that the torpor which affects some aviators in too swift ascent or descent, and which is held responsible for many fatal accidents, comes from insufficient responsiveness of the arteries to changed pressure conditions, and this is easy to comprehend, since whatever affects arterial pressure must affect the supply of blood to the brain.

In this connection a very curious and significant discovery has just been announced by Dr. P. Bonnier. It has long been known that the *medulla oblongata,* the bulbous mass of gray and white nerve matter situated at the top of the spinal cord, governs the involuntary actions of heart and lungs. This is the reason why injuries to the neck are so uniformly fatal in nearly all instances, while life may be prolonged for years when other portions of the spinal cord or the brain itself have been injured. Dr. Bonnier has now shown the existence in the *medulla* of manostatic centers whose function it is to produce an equilibrium between the interior pressure of the blood and the exterior pressure of the atmosphere.

Furthermore, in subjects whose arterial pressure is supernormal because of defective action of the nerve centers, he has proven the possibility of rousing the activity of these by means of a very simple operation, consisting of a slight nasal cauterization at a point connected with the area of the *medulla* where the centers in question are found. The return of the arterial tension to the normal following the operation is often immediate and seems to be permanent, though judgment must be suspended on this point until the early experiments are confirmed.

However, Dr. Bonnier cites one case of greater interest—that of a young man who suffered from circulatory oppression and dizziness at each descent. His arterial tension was regulated and reduced from 22 to 16, a tension which has been normally maintained ever since (a period of four months at the time of writing), with the result that he has experienced only a slight discomfort in place of his former oppressive sensations during descent. Thus it would seem that in some instances, at any rate, the aviator may be able to control his arterial tension and "regulate his manostatic capacity with as much care as his motor."—*Scientific American Supplement.*

MILITARY AEROPLANES

The difficulties in the way of rendering an aeroplane a thoroughly practical machine have been strongly emphasized during the trials of military types held at Rheims in October, 1911. Even in its present form the aeroplane is of great utility, and no one will contest its value for military purposes in view of the work it is doing in Tripoli, where it has, on more than one occasion, been of marked value to the Italians.

But the aeroplane does not yet satisfy military requirements. It must carry at least one observer in addition to the pilot; it must be able to resume its flight unaided on any ground where it may happen to alight; and it must be absolutely reliable. The conditions imposed by the French military authorities are very severe, but this has not debarred makers from doing their best to satisfy them. The machines at Rheims are nearly all fitted with engines of 100 to 140 horse power. There are monoplanes and biplanes and triplanes, and a machine with four engines which can be run separately or simuleaneously for varying speed. There has been a good deal of controversy as to whether the monoplane or multiplane is preferable for military work, but no light has been thrown on this matter at Rheims, for the reason that up to the present time it has been impossible, on account of the weather, to carry out the programme.

Two or three men have been killed during the experiments, but, on the other hand, Vidart has done some surprising work with a monoplane when caught at a fairly high altitude in a storm. So far as they have gone the trials of these powerful machines under favorable weather conditions have not given altogether encouraging results. Meanwhile, the Wright brothers claim that they are in a fair way to perfecting a machine which will hover in a breeze and will only need an engine of small power. It is by experiments like these that we may hope to see the design of aeroplanes saved from the rut into which it appears to be descending.—*The Engineer,* London.

NEW TYPE OF LOCOMOTIVE

An interesting and novel type of locomotive is being developed under the patents of James Dunlop, of Glasgow. It is driven by compressed air, which is supplied by an oil engine-driven compressor. The compressed air is used on the closed circuit, sometimes called the dense-air system, in which a certain quantity of air passes continuously from the compressor to the engine or driving air motor, and then back to the compressor again. Leakage is automatically made up by a small auxiliary compressor. It is claimed that the closed circuit system is more efficient than the open-circuit system in which fresh air is continuously being taken in by the compressor and the exhaust from the motor rejected to atmosphere. In the closed circuit system the average air pressure throughout the system is maintained at some figure, say 150 pounds per square inch, the intake pressure at the motor being higher and the outlet lower. The range of pressure is governed by the control of the compressor and the cut-off of the motor. The compressor may be controlled by varying its speed, but more usually by altering the number of cylinders in action, this being done by lifting the air delivery valves off their seats in those cylinders to be put out of action. The air in the delivery main is then merely drawn in and pushed out through the open valve. Whether the high efficiency claimed will be attained remains to be tested. In this case it is possible to increase the economy materially by heating the air before it enters the motor cylinders by means of the exhaust gases from the oil engine. It is claimed that the fuel cost will be $2.19 per 1,000 effective horsepower hours with oil at $10 a ton, as against $3.80 for a steam locomotive with coal at $2.50. These costs are based on 0.51 pound of oil per b. h. p. at the engine, a recovery of 16 per cent. of the heat in the exhaust gases, and a mechanical efficiency for the locomotive of 90 per cent. For the steam locomotive 3½ pounds of coal per h. p. hour has been allowed. The calculations for the air locomotive seem to be based on quite the most favorable conditions, and it would be surprising if the average results were nearly so good under service conditions. The system is, however, a very interesting attempt to utilize the non-reversing internal combustion engine for locomotive work, and the practical results will be eagerly looked for.

NOTES

The six gas engines being installed as the initial group in the new power house of the Indiana Steel Co. at Gary, Ind., are the largest units ever constructed, and have a rating of 3,200 kilowatts (4,288 H. P.) each. The new engines are of the twin tandem double-acting Allis-Chalmers type, with cylinders 44 by 60 in. The engines will operate on blast furnace gas, and are to drive alternators delivering 6,600-volt, 25-cycle, 3-phase energy to the power network of the Gary mills.

The first step in preliminary construction preparatory to building the highest dam in the world has been accomplished in the completion of the mammoth diversion tunnel at Arrowrock dam, Boise irrigation project, Idaho. This tunnel, when lined with cement, will be 25 feet high and 30 feet wide, larger than a double track railroad tunnel, and will carry the whole flow of the Boise River during the construction of Arrowrock dam. The tunnel is 470 feet long and driven through solid granite for its entire length. Its excavation was completed several days ahead of schedule time.

A Prominent Maker of Air Compressors is in need of three experienced and efficient salesmen. State in detail previous experience, references and compensation expected. Answer in hand writing. Address Compressed Air Magazine.

The use of fertilizers, in which potassium salts are essential constituents, is constantly growing, and it is interesting to note, in passing, that a bank in Illinois has established a loan fund, free of interest, to enable the farmers of that district to invest more freely in fertilizers and to raise correspondingly larger crops.

The first city subway in Italy is to be constructed at Naples at a cost of $3,000,000. The line will be both urban and interurban, the former with a total length of 8 kilometers (4.97 miles) and the latter 10 kilometers (6.21 miles) and is to be completed in four years. Similar projects are under consideration both at Genoa and Rome.

Winthrop Talbot, M. D., in an address before the recent convention of the National Association of Machine Tool Builders, said that from experiments carried on under his direction, it was found that the greatest average comfort from surrounding air conditions came from a temperature of 65 to 70 degrees, a relative accompanying humidity of 50 to 60 per cent. and an air velocity of from 2 to 5 feet per minute.

In the acetylene-burning lighthouses along the Panama canal will be installed copper cylinders exposed to the sun. When the sun rises in the morning and the rays fall upon these cylinders they will expand and close valves that admit gas to the burners. As night approaches and the sun's rays diminish in power the cylinders will contract and again turn on the gas, which will be ignited by small pilot jets.

Professor Jamieson, of the Oklahoma State Normal School, some time ago on a foggy morning discharged into the atmosphere some liquid air—and afterwards it rained. He says that he is going to take an airship and try the liquid air above the clouds, and he expects to cause considerable precipitation. His expector must work easily.

Experiments undertaken for measuring the temperature on the inner surface of the cylinder of a small gas engine have shown that the temperature is about 465 degrees F., and that the variation from cycle to cycle is usually less than 18 degrees F. The steady conditions of low temperature at the wall surface were caused by the jacket water, while very great changes of heat take place at a very short distance from the walls.

It is stated by Stewart W. Young (U. S. pat. No. 1,011,699) that by the use of a small cartridge containing ammonium carbonate, 65 per cent.; potassium bichromate, 33 per cent.; and camphor, 2 per cent., in holes containing high explosives, the gases will be rendered inoffensive. A somewhat cheaper composition which he also proposes (U. S. pt. 1,007,409), is a mixture of 65 parts ammonium carbonate and 35 parts of manganese dioxide.

According to the *Brass World*, a recent experiment in copper melting in an electric furnace produced a peculiar physiological action. Some 5,000 pounds of pure eletrolytic copper were melted in a three-phase arc furnace. After a few hours all of the 10 men employed experienced difficulty in breathing. For the following 24 hours the men were attacked with a severe nausea, followed by a soreness of the entire system similar to that of acute grippe.

The Los Angeles Aqueduct is progressing at a rate which promises completion early in 1913. On December 15, 1911, the last tunnel of the Little Lake Division, Tunnel 10A, was holed through. This tunnel, 5,960 feet long, is fifth in length on the Aqueduct; the longest, the Elizabeth Lake Tunnel, 26,870 feet, was completed early in the current year. Tunnel 10A was begun March 10, 1910. Its completion leaves only about 4,000 feet of tunneling to be done on the Aqueduct, out of a total of nearly 43 miles.

After the experience in cutting with a hacksaw the heavy steel bars which guarded the windows of the Equitable Building, in order to rescue men in the cellar, the New York Fire Department has ordered portable oxyacetylene outfits for the down-town districts. With the mercury hovering around zero, the hacksaw is a very slow proposition, particularly for the man whose life depends on the bars being sawed before the fire reaches him. This is supposed to be the first instance of these outfits being used by fire departments.

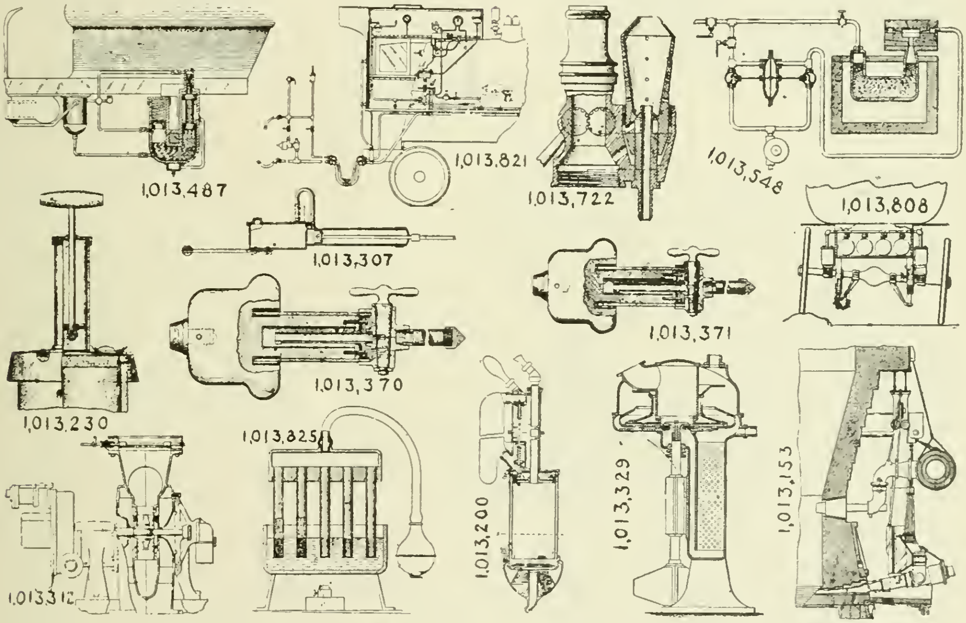
A room may be too damp for human occupancy, without showing the growth of molds or mildews, or the formation of crystals upon the walls. In order to test the habitability of a room with respect to humidity, *Le Journal de la Sante* recommends placing about two pounds of freshly slaked lime in the room, sealing up all doors and windows tightly, and leaving for twenty-four hours. If the increase in weight during this time (absorption of water) exceeds ten per cent. of the weight of the lime, the room should not be considered healthful.

The following color scheme for piping is from a German gas journal: Red means fire, whether it is a hydrant, bucket, axe or anything else. Green is for water pipes; blue, for air; white, steam; black, tar; rose, ammonia or alkalies; brown, oil; gray, vacuum; rose with red stripe, acids. Yellow is a general color for gases. If the yellow is alone, it means purified blast furnace gas, or if with a black ring, it is not purified; yellow with a blue ring means producer gas; with a rose-colored ring, illuminating or coke-oven gas; a green ring means water gas, and a brown ring oil gas.

The construction of a freight tunnel under the Hudson River, to be built by New York and New Jersey, is proposed as part of a plan for the comprehensive development of the port of New York. It is suggested that the rates be fixed by the Interstate Commerce

Commission, as it is believed that this arrangement would abolish terminal competition. Some years ago a freight tunnel was proposed as part of a shore-line tunnel extending around the lower part of Manhattan Island, both the Manhattan and the Hudson River Tunnels to be connected with an assembling and distributing station in New York.

The solid crust of the earth, with a specific gravity of only about 2.5, as against 5.7 for the entire globe (crust and liquid or semi-liquid interior) is said by Rosenbusch to consist of the various elements in the following proportions by weight: Oxygen, 47.29 per cent.; silicon, 27.21; aluminium, 7.81; iron, 5.46; calcium, 3.77; magnesium, 2.68; sodium, 2.36; potassium, 2.40; hydrogen, 0.21; titanium, 0.33; carbon, 0.22; chlorine, 0.01; phosphorus, 0.10; manganese, 0.08; sulphur, 0.03; barium, 0.03; chromium, 0.01.



PNEUMATIC PATENTS, JANUARY 2.

Writing in the *Journal of Gas Lighting*, Mr. Alwyne Meade describes a system of "sand spraying" iron or steel to prevent corrosion. With this method, a thin coating of fine silver sand is sprayed on to the paint while the latter is still wet. The paint is allowed to dry, another coat is then applied, and this also sprayed with sand, and finally a third coat is put on, but the sand is not sprayed on to this. When the whole has thoroughly dried, the sand combines with the paint and forms a hard shell, which is very much better able to resist the inroads of the rust-producing agents. This method is particularly adapted for use with mild steel plates and rolled steel beams; and in all cases the writer recommends that the particular object being treated should be thoroughly scraped and brushed with a wire brush, and a coat of red-lead paint—without the sand spray—should be applied before the painting as suggested above is commenced. This coat should follow immediately after cleaning.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 2.

1,013,121. FLUID-OPERATING MECHANISM. ARTHUR AUGUSTUS BROOKS, Ashton-upon-Mersey, England.

1,013,147. VACUUM CLEANING APPARATUS. LOUIS W. G. FLYNT, Rochester, N. Y.

1,013,153. CLAY-GUN. FREDERICK H. N. GERWIG, Pittsburgh, Pa.

1,013,200. VACUUM-PRODUCING APPARATUS. JOSEPH F. MENNINGEN, West Allis, Wis.; Katherine Menningen administratrix of said Joseph F. Menningen, deceased.

1,013,230. VACUUM PACKING APPARATUS. GRAY STAUNTON, Evanston, Ill.

1,013,259. PNEUMATIC VALVE - ACTION. Frank L. Yetts, New York, N. Y.

1,013,307. SPRAYER. John Franklin Patterson, Warren, Ohio.

1,013,312. CENTRIFUGAL COMPRESSOR AND PUMP. Richard H. Rice, Lynn, Mass.

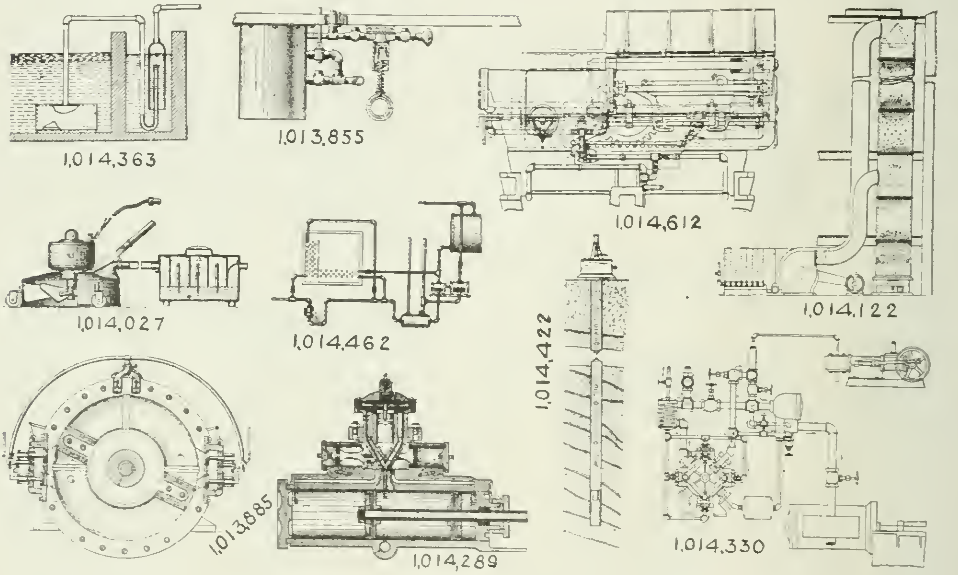
1,013,329. CENTRIFUGAL PUMP OR COMPRESSOR. Fritz Strohbach, Charlottenburg, Germany.

1,013,370. FLUID-PRESSURE COMPRESSION OR HOLDING DEVICE. Joseph Boyer, St. Louis, Mo.

1,013,371. PNEUMATIC RIVET-HOLDER. Joseph Boyer, Detroit, Mich.

1,013,460. PROCESS OF PREPARING NITROGENOUS COMPOUNDS. Leland L. Summers, Chicago, Ill.

1. The process of preparing nitrogenous compounds which consists in introducing into heated carbonaceous material liquefied gas containing nitrogen.



Pneumatic Patents, January 9.

1,013,487. PNEUMATIC SPRING FOR VEHICLES. Lucien R. Gruss, Chico, Cal.

1,013,528. COMBINED INTERNAL-COMBUSTION AND COMPRESSED-AIR ENGINE. John K. Broderick, St. Louis, Mo.

1,013,548. ART OF MAKING CASTINGS. Charles M. Grey, East Orange, N. J.

1. In the art of making castings, the process which consists in confining fluid material in two chambers having communication beneath the surface of said material, and producing a partial vacuum in the said two chambers above the metal therein by exhausting air from both of said chambers.

1,013,690-1. APPARATUS FOR TREATING SNAP-BOLLS. James A. Shields, Atlanta, Ga.

1. The process of treating snap bolls for the recovery of the fiber thereof, consisting in crushing said bolls; transferring the crushed bolls by suction; separating the boll husks from the fiber; transferring the fiber by an air blast to make it fluffy and finally ginning the fiber, substantially as described.

1,013,722. AIR-PURIFYING INHALER ATTACHMENT. Samuel Banta and Benjamin L. Stowe, Jersey City, N. J.

1,013,730. VACUUM-TRAP. John A. Bemish, Rochester, N. Y.

1,013,772. HUMIDIFIER. Robert C. Herren, Kenton, Ohio.

1,013,808. PNEUMATIC SPRING FOR VEHICLES. Charles R. Palmer, Cincinnati, Ohio.

1,013,821. SAFETY DEVICE FOR FLUID-PRESSURE BRAKE SYSTEMS. William H. Sauvage, New York, N. Y.

1,013,825. METHOD OF PRODUCING MOUTHPIECES ON CIGARETTES. Lewis H. Sondheim, New York, N. Y.

1. A method of forming mouth-pieces on cigarettes, consisting in impregnating an end thereof with a binding substance, and producing an air current therethrough.

JANUARY 9.

1,013,855. VEHICLE-SPRING. Warren W. Annable, Grand Rapids, Mich.

2. In combination with a vehicle, a pneumatic spring, a pump to supply compressed air to the spring and mounted on the body of the vehicle, a rod movably connected to the pump piston at one end and attached to the spring support at the other end, and a spring yieldingly engaging the piston to operate the same.

1,013,885. FLUID-PRESSURE MOTOR. Joseph McConnell, Connellsville, Pa.

1,014,027. PNEUMATIC CARPET-SWEEPER. David C. Walter, Toledo, Ohio.

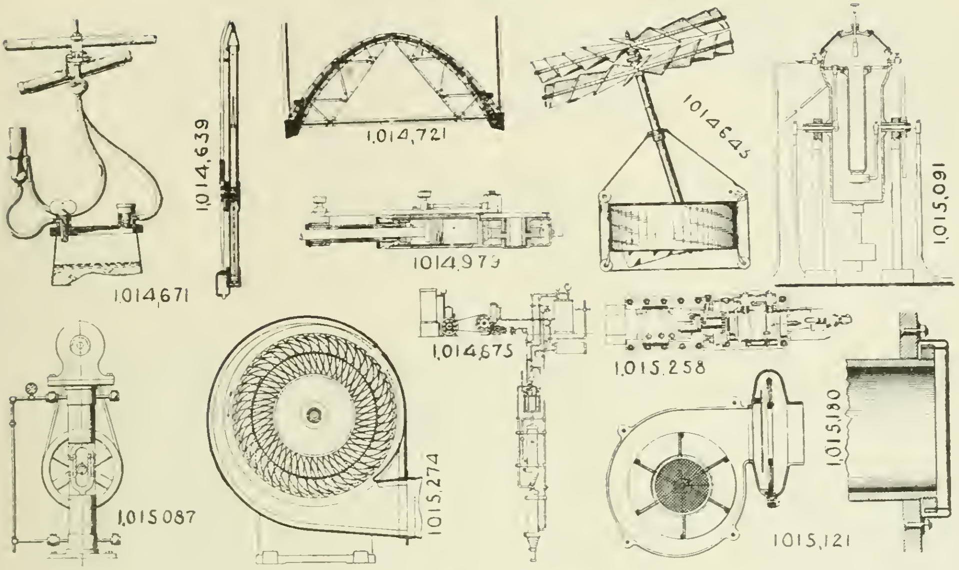
1,014,122. GRAIN-DRIER. John B. Cornwall, Moline, Ill.

1,014,289. PUMP. Samuel E. Folk, Bryan, Ohio.

1. In an apparatus of the class described, the combination with a pump, fluid pressure actuated mechanism for operating said pump, and a closed receptacle to which fluid is delivered by said pump, of means associated with said mechanism and actuated by both fluid pressure therein and by pressure within said receptacle for automatically controlling the passage of the actuating fluid to or around said pump actuating mechanism.

1,014,330. APPARATUS FOR HEATING COMPRESSED AIR. Sidney A. Reeve, Worcester, Mass.

1,014,347. HOT-AIR HEATER. Henry Strand, Cleveland, Ohio.



Pneumatic Patents, January 16.

1,014,363. AIR-FLUSHING APPARATUS. Hubert Beddoes, Philadelphia, Pa.

1,014,364. PNEUMATIC PIANO. William G. Betz, Chicago Heights, Ill.

1,014,422. COMPRESSED-AIR PUMP. William E. Stuart, San Francisco, Cal.

1,014,62. DRYING SYSTEM. William M. Grosvenor, Grantwood, N. J.

1,014,545. AUTOPNEUMATIC PLAYING DEVICE FOR MUSICAL INSTRUMENTS. Charles Warren, Rockford, Ill.

1,014,612. DUMPING-CAR. Erwin C. Sherman, William W. McKelvey, and Edgar J. Reilly, Youngstown, Ohio.

2. A dumping car, a fluid pressure motor geared to the car to effect the dumping movements thereof, a source of fluid pressure supply for the motor, and valve means for controlling the operation of the motor to dump the car at an increasing velocity during the last portion of such movement, substantially as described.

JANUARY 16.

1,014,639. PNEUMATIC HAMMER FOR DRIVING NAILS. William Evans Colwell, Kincardine, Ontario, Canada.

1,014,643. AERIAL VESSEL. John J. Donnelly, Denver, Colo.

1,014,671. MILKING APPARATUS. David Townsend Sharples, West Chester, Pa.

1,014,675. PUMP. Isaac R. Stout, Medicine Lodge, Kans.

1,014,721. PNEUMATIC CAISSON OF FERRO-CONCRETE. Stanislaw Rechniewski, St. Petersburg, Russia.

1,014,729. VACUUM - CONTROLLER FOR PNEUMATIC CLEANING APPARATUS. John Strother Thurman and John Alexander Dunlap, St. Louis, Mo.

1,014,778-9. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind.

1,014,979. PERCUSSIVE DRILL, HAMMER, OR LIKE PERCUSSIVE TOOL OR MACHINE. Alfred Sykes, Huddersfield, England.

1 015,087. AIR-PUMP. Gottfried Schmidt, Hazleton, Pa.

1,015,091. APPARATUS FOR MELTING AND MIXING METALS IN VACUUMS. William Speirs Simpson, London, England.

1,015,121. HAIR-DRIER. Alfred Barker, Philadelphia, Pa.

1,015,180. FLUID-TIGHT EXPANSION-JOINT. Charles Easton Heitman, New York, N. Y.

1,015,258. CHANNELING-MACHINE. Albert Ball, Claremont, N. H.

1,015,274. CENTRIFUGAL FAN. James Keith, London, England.

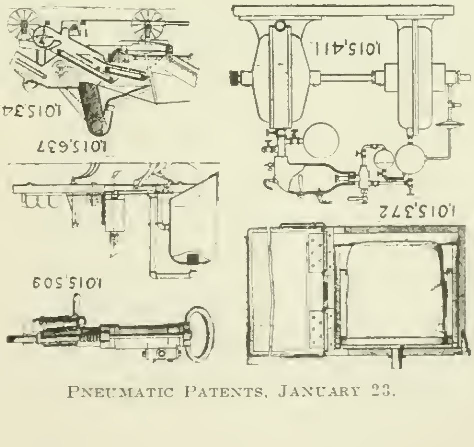
JANUARY 23.

1,015,346. SUCTION DEVICE FOR CORN-SHELLING MACHINES. Clyde M. Rushing and Albert J. Wheeler, Charleston, Mo.

1,015,372. PNEUMATIC CLEANING - MACHINE. Morris S. Wright, Worcester, Mass.

1,015,411. MOTOR. Samuel J. Webb, Minden, La.

1. An apparatus of the class described comprising a source of compressed air, means for maintaining the pressure of the air below a predetermined amount, a working fluid generating chamber, a fuel supply chamber, a mixer, means connecting the source of compressed air with said mixer, means connecting the fuel chamber with said mixer, means connecting the source of compressed air with said fuel chamber, means connecting said mixer with said generating



Pneumatic Patents, January 23.

chamber, and a safety valve on said generating chamber and adapted to maintain the pressure in said generating chamber below the pressure in said source of compressed air.

1,015,509. HAMMER-DRILL. William Prellwitz, Easton, Pa.

1,015,637. STREET-CLEANING MACHINE. Le Roy H. Roby, Fostoria, Ohio.

JANUARY 30.

1,015,782. PUMPING APPARATUS. Xenophon Caverno, Kewanee, Ill.

1,015,800. PROCESS OF LIQUEFYING AIR AND SEPARATING IT INTO ITS ELEMENTS. Ernst Janecke, Hanover, Germany.

A process of liquefying air and separating it into its elements, consisting of liquefying air under pressure by bringing it into indirect thermal contact with a liquid rich in liquid oxygen whereby the said liquid is made to evaporate, then bringing a given quantity of the liquid air so produced into indirect thermal contact with the vapors given off by the liquid rich in oxygen, causing a part of said liquid air to evaporate at less than atmospheric pressure, thus causing a part of the vapors given off by the liquid rich in oxygen to reliquefy, and then adding the part of the liquid air not evaporated and the liquid obtained by the partial condensation of the vapors to the liquid rich in oxygen.

1,015,824. DUPLEX PRESSURE-CONTROL APPARATUS. Howard M. P. Murphy, Pittsburgh, Pa.

1,015,855. DUPLEX PRESSURE-CONTROL APPARATUS. Walter V. Turner, Edgewood, Pa.

1,015,875. HYDROGEN-GAS GENERATOR. William Leonard Dolben, Chicago, Ill.

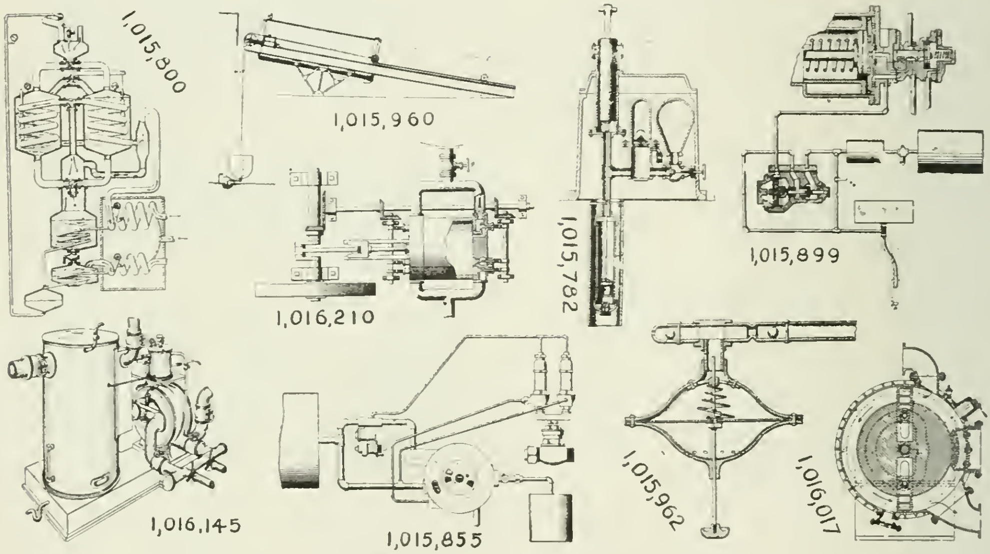
1,015,894. VACUUM-CURRYCOMB. William H. Keller, Philadelphia, Pa.

1,015,899. AUTOMATIC TRACK-SANDING DEVICE. Fremont P. Livingston, Denver, Colo.

1,015,921. AIR-MOTOR GEAR. Carl J. Zirbel, Montezuma, Iowa.

1,015,960. SLIMES-FILTERING APPARATUS. David J. Kelly, Salt Lake City, Utah.

1. In apparatus of the character described, the combination with a tank having an open end, a filter-carrier movable in and out of the tank, and provided with a head adapted to close the open end of the tank, locking mechanism between the head and tank, and a fluid-pressure mechanism for actuating the locking mechanism.



Pneumatic Patents, January 30.

1,015,962. PNEUMATIC PUSH-BUTTON AND PUMP. George A. Kenner, Herrin, and William H. Michael and Thomas J. Burton, Murphysboro, Ill.

1,016,004. MILKING-MACHINE. Cyril Edmund Gane, Normanby, New Zealand.

1,016,017. PNEUMATIC PUMP FOR LIFTING GRANULAR MATERIALS. Emilian Koltschanoff, Taganrog, Russia.

1. In a pneumatic pump for lifting grain and the like, the combination of a rotary pump provided with a suction-pipe and an outlet-pipe, the former for sucking the grain with the air into the space between vanes of the pump, and the latter for delivering the grain by the compression-action of the pump into the delivery pipe, and an air inlet valve in the space between vanes of the pump.

1,016,145. PROCESS OF DISINFECTING INCLOSED SPACES. George Harker, Petersham, New South Wales, Australia.

1. The process of disinfecting which consists in charging a gas incapable of supporting combustion with a fluid disinfecting agent which, when mixed with air alone, is inflammable, the fluid mixture being constituted in such proportions as to be non-inflammable, and conducting such mixture to the point of use.

1,016,157. AIR COOLER AND PURIFIER. Carl Jost, Bombay, India.

1,016,161. FAN ATTACHMENT FOR ROCKING-CHAIRS. Ernest C. Killebrew, Evansville, Ind.

1,016,210. MEANS FOR CONVERTING VAPOR ENERGY INTO WORK. Elza J. Christie, Marion, Iowa.

2. In a motor adapted for the use of a mixture of steam and compressed air, the combination of a working cylinder having a reciprocating piston therein, and valves respectively adapted to admit atmospheric air at one stroke and to hold it in the cylinder while undergoing compression on the return stroke, another valve adapted to admit steam at the next succeeding stroke to commingle with the compressed air and final exhaust valve, and means for actuating these respective valves in due time and sequence.

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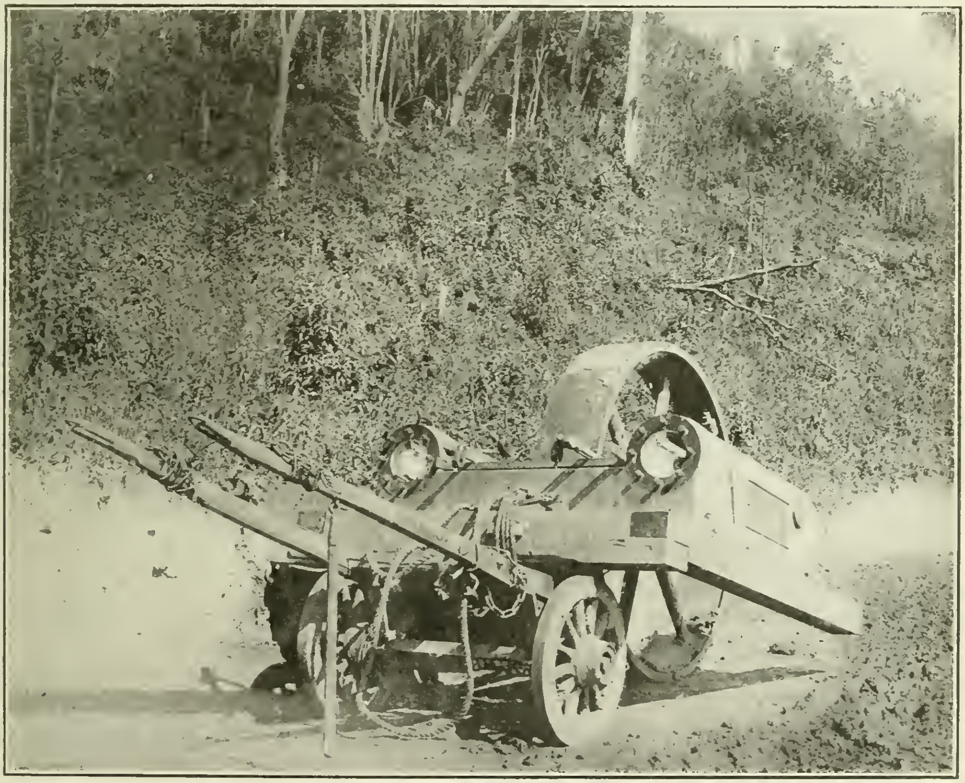
COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XVII APRIL, 1912 No. 4



COMPRESSOR CARRIES ITSELF.

NOT PATENTED

The photos reproduced upon this and the following page came to the editor of Compressed Air Magazine from Mr. D. H. Campbell, Rio Janeiro, Brazil. They tell clearly and completely the story of a unique scheme of machinery transportation. It is seldom that a patented device—which this of course is not—embodies such an example of successfully applied ingenuity.

In his letter accompanying the photos Mr. Campbell says: "I enclose a couple of views of an Imperial, Type X., air compressor in transit which may be of interest to your readers."

It will be noted further along that not only one but several compressors have been transported as here shown.

Continuing, the letter says: "To meet the conditions of these roads in the rainy season,

ON A ROAD IN BRAZIL.

the deep mud, the sharp turns on heavy grades, I resorted to the expedient shown. The machine is stripped of everything so that there is only the bedplate with crank shaft and wheel, and the weight is practically all on the wheel, the face of which is so wide that it does not sink much in the mud and the short wheel base make it easy to get around the sharp turns.

"Going down hill I drove a wedge between the face of the wheel and the bedplate to act as a brake. It was necessary to guide with men and not rely on the oxen.

"I find that I can move one of these machines in this way in the rainy season at the rate of 8 kilometres (5 miles) per day on 12 per cent. maximum grades. The roads are new with long 'supported' grades of uniform rates; but 18 head of oxen are sufficient for a 12 per cent. grade.

"The compressors have been delivered in this manner without injury of any sort."

The air pressure produced by an explosion often renders a miner unconscious, so that the after-damp catches and kills even when the victim was neither burned nor near the initial explosion.

AVIATION SPEED RECORDS

On January 19th Vedrines, on a 100-horse-power Gnome-engined Deperdussin monoplane broke Nieuport's records for all distances from 5 to 40 kilometers, his 100-kilometer (62.1 mile) record, and C. T. Weymann's 150-kilometer (93-mile) record made in a 100-horse-power Nieuport monoplane when he won the Bennett Cup race on July 1st, 1911, in England. Vedrine's records for 5, 10, 20, 30 and 40 kilometers in minutes and seconds, are, respectively, 2:06 2/5; 4:13 2/5; 8:26 3/5; 12:40 4/5; 16:53. One hundred kilometers were covered in 41:56 4/5 as against 46:27 2/5 by Nieuport; and 150 in 62:43 4/5 as against 71;36 1/5 by Weyman. In one hour Vedrines flew 142.43 kilometers (88.50 miles), showing that his speed was 8 1/3 miles per hour faster than that attained by Nieuport. The fastest speed made in any 5-kilometer circuit was 145.177 kilometers, or 90.2 miles an hour. This was 7½ miles per hour faster than Nieuport's fastest lap. On January 24th Maurice Tabuteau, with a Borel monoplane, made new records for 200, 250, and 300 kilometers (124.28, 155.35, and 186.41 miles) of 1:54:21; 2:22:57; and 2:51:00, respectively. His average speed for the first mentioned distance was 64.87 miles per hour.

AMERICAN AND FOREIGN WAGES AND EFFICIENCY

BY W. L. SAUNDERS.

[The Editor of Compressed Air Magazine recently completed a five-months' journey around the world. A meeting of the American Institute of Mining Engineers having been held in San Francisco, a number of the members took the opportunity to visit Japan, while Mr. Saunders with some others of the party entered Korea and then crossed Siberia to Europe, visiting a number of countries, including Russia, Germany, Austria, France and England. The views here presented have special pertinence as bearing upon pending National and current popular discussion. R.]

Any one who travels for the first time over new fields with his mind free and his interest centered upon business conditions in manufacturing is a very poor judge of things, but a man who goes over beaten tracks from time to time with the same ends in view and with past experiences to steer him should be competent to draw comparisons and to reach conclusions with some degree of accuracy and value.

The manufacturing world is not large and that part of it which makes machinery is a comparatively limited field. The land of this world is more largely given up to agriculture than to any other purpose. Farming does not concentrate population or build up large cities. The products of the soil are greater in value than anything else that is produced, not only because the people are fed, but through the income derived from Nature's products. Railroads are mostly made possible and profitable through agricultural conditions. The same may be said of shipping and of a great many other things which add to the wealth and prosperity of the people, but next in importance to every country and to all people is the development of its manufactures.

MANUFACTURING CENTRES NOT BUILT ON CHEAP LABOR.

In looking for causes which have produced great manufacturing centers two things stand out prominently, namely, favorable natural conditions and markets. A plentiful supply of crude labor is not a condition of such great importance as is popularly supposed because where there is an abundance of labor and where it is cheap the best and most productive manufacturing does not exist. Take, for instance, India, China and Japan, countries where there is a plentiful supply of cheap and intelligent labor, which might through proper training be made to produce iron and steel products, for instance, equal in efficiency to the English, American and German products, yet no such results have been derived, and the answer usually given, that it is because of lack of capital, is not a true answer, because if it were the fact that to cut labor in two would save money and add to profits in any line capital would flow in that direction. Capital for this purpose usually concentrates itself as near as possible to the markets where each particular product is consumed, and the very fact that it does so concentrate itself means so great an enlargement of these markets through increased population and prosperity that new fields are not sought.

EFFICIENT LABOR THE BASIS OF SUCCESS.

In mechanical things, at least, skilled labor is really the essential basis of success in manufacture. The first and largest item on the cost sheet is the item of labor and the maker who thinks that because this is true he should turn to a country where labor is cheap will surely court disaster. Efficiency of labor and the best tools are the important things which maintain supremacy in any line. Efficient labor comes through the work of a life time and cannot be made in a day. It is furthermore plain to those with the world's experience before them that just in proportion as labor becomes more efficient and as tools become more productive does the price of labor go up, and this is the chief thought which has impressed me during a recent trip around the world.

England was up to recent years in advance of any other country in mechanical manufacturing. America with higher labor and Germany with lower labor have both made considerable headway against her. In the case of America the headway has not been made because labor was higher but in spite of it and because of other conditions which have compensated for higher labor. In Germany the progress has not been because of lower labor, but through the spirit of her people, coupled with good engineering and business energy and push, equal if not greater to that of America.

BRITISH AND GERMAN LABOR COSTS ADVANCING.

It is worthy of notice that while the price of mechanical labor in America had stood comparatively still, or has had but a moderate advance during say the last twenty years, the price of the same labor in Germany and England has increased at least one hundred per cent. Mechanical labor in Germany, which is today one-half that of the United States, was but one-quarter twenty years ago.

It is usual to attribute this to the growing strength of labor unions, and it must not be forgotten that labor unions have added materially to the strength of labor in the countries mentioned, but labor unions are only strong where they are able to exercise at least some control over the situation, either through a limited supply, through legislation or otherwise. In a country like Japan, for instance, labor is so plentiful, both male and female, that unions are made hopeless in their efforts to control, and a manufacturer there who might be disposed to rebel against labor union requirements would draw from this large field and cultivate new men rather than submit.

JAPAN'S LABOR LOW PRICED AND INEFFICIENT.

In such large plants as the Imperial Steel Works of Japan mechanical labor costs about 30 cents a day for men and 15 cents for women. Women in Japan in many cases replace the men, except in places where heavy work is required. In a copper smelter in Japan I saw a young girl handling the levers by which the transportation cars were shifted. For this she received 10 cents per day. The man who lifted the metal from the car was receiving 20 cents per day, yet it is a fact that notwithstanding these astonishingly favorable conditions, so far as labor is concerned, the Imperial Steel Works, for instance, do not pay, though the product is equal to that produced anywhere else. One naturally looks for a reason for this, because the Steel Works are located at tide water and transportation in ships is not expensive. The conclusion is inevitable, that this labor per unit is of very low efficiency and that it cannot be made efficient except through long years of experience and with markets sufficient to warrant a large product of each one thing. Here we come to the revelation of the true reason of American progress in these lines. Our markets are so close and so fruitful that the single high-priced man working on a single thing each day gets the labor unit of cost down and this fact has enabled American manufacturers to compete in foreign fields.

We must not, however, lose sight of the gradual and pronounced increase in the cost of labor in foreign manufacturing countries. Should Japan, for instance, ever reach prominence in her steel manufacturing we may rest assured that at that time her labor prices will be increased several hundred per cent.

GERMAN COMPETITION TO BE FIXED.

Japan is not a manufacturing country and is not likely to be within the life time of those who may be interested in this subject, so the practical question to consider is which country is that which threatens English and American supremacy, and in considering this let us look into the reasons. The answer is plainly Germany. The Germans are natural mechanics. They are intelligent, resourceful and they work like beavers. There intelligence is initiative and inventive. Inventive to the extent of not only originating things, but they have the greater faculty from the commercial standpoint of taking advantage of things which may have originated elsewhere, improving them, perfecting them and making the best possible use of them.

There is nothing altruistic or sentimental about the German manufacturer. He goes for the thing that is best and he studies the best and cheapest way to produce it. The German mechanical engineer is equal if not superior to any one working in the same field. He is a student of detail. He takes nothing for granted, he finds out what has been done elsewhere, how far it goes, and he studiously and on practical lines seeks ways and means by which to go one step further. Take the steam engine, for instance, which we are accustomed to look upon as an American product. It was invented in England, but the invention of anything mechanical is only the first step toward success. Watt, Newcomen, Corliss and others, carried the engine through successive steps of higher efficiency until we in America practically laid down on the Corliss, thinking that we had reached the limit of efficiency for the reciprocating type of machine. The Germans did not stop, and it is a fact which can hardly be disputed, that today the reciprocating engine has reached a higher stage in Germany than anywhere else in the world. Through the use of poppet valves, steam heating, and greater attention to details, the Germans are offering reciprocating engines at an efficiency lower than American or English manufacturers. I do not refer to the Diesel and other special types of reciprocating engines, but to the regular steam engine, which notwithstanding the Turbine and other means of producing horse power from steam, still holds its place in the largest field and with the highest efficiency under general conditions of service.

GERMAN WAGES AND EFFICIENCY RISING TOGETHER.

The steam engine is only used to illustrate the point, which is that German growth, which might almost be said to be supremacy in certain mechanical fields, is not due alone to German cheap labor. At the present time German labor is cheaper, but it is going up faster than the labor of England or America, and its unit of efficiency grows in the same proportion as the price increases. German manufacturers are located under favorable conditions for material and markets; they have plenty of iron, coal and limestone at their doors and large shipping, and markets extending throughout Europe, Asia and South America. The product is on a large scale in those lines where experience has been extensive and they have the brains, the push and the money to reach other and even competitive countries.

PENDING TARIFF LEGISLATION.

This brings us to the all important question of tariff. The American tariff has heretofore been prohibitive. Shall we now take down the bars and admit German products which will surely come? Are American manufacturers in mechanical lines ready to meet this competition on practically equal terms? Have they had time enough to prepare for it and is it their fault if they are not ready?

In the first place, every fair man will acknowledge that if we are to remove mountains we should begin on grains of sand and that whether we are protectionists or free traders a condition exists and has existed for a large period of years which has materially aided the building up of American industries. That condition is one of high protection. All plans have been made under it. The wheels of our works have been tuned to it and the avenues are paved for it, so that whether we are ready or not no concern should be put to the test of a sudden and radical change in well established conditions of business. Time should be given to prepare for the assaults of a business enemy and justice in this line can only be done by taking down the bars one at a time, with sufficient time in between to safeguard the property of the people and to maintain the stability of our industrial conditions. True protection is that which protects those industries only which require it, and without providing the opportunity for monopoly abuses.

THE OZONE FAD

Faith in the subtle and far-reaching effects and the health-giving virtues which have at one time or another been attributed to ozone has somehow been instilled into the popular mind. Seaside and mountain resorts alike have benefited by the reputation of "ozone in the air" in the neighborhoods involved. The excusable longing of an ever-ailing population for a stimulating atmosphere and for an ideal antiseptic has led many to look hopefully toward that substance which appears to represent the acme of the valuable properties of oxygen. The honest manufacturer and the medicine faker have both been alert to avail themselves of the opportunity for public service, so that "ozonizers" and "ozonized" products are displayed in abundance.

The ozone question presents its facts as well as its fiction. Ozone undoubtedly has antiseptic power; but for such effects a dangerous concentration appears to be necessary. Lately it has become possible to prepare pure ozone and to investigate its physiologic properties. Prof. Leonard Hill and Dr. Martin Flack of London find that "a concentration as little as one per million is irritating to the respiratory tract. Exposure for two hours to a concentration of fifteen to twenty per million is not without risk to life."

The concentration of ozone necessary to kill bacilli would also kill tissues in which they occur. There is no harm in breathing weak concentrations of ozone. Ozone in somewhat higher concentrations (one per million) may have some value, but proof of its value may well be demanded, especially so long as there are other and better curative agencies—*The Journal of the American Medical Association.*

CEMENT GROUT AND COMPRESSED AIR IN SHAFT SINKING

BY R. C. JOHNSON.

Without doubt the most important step that has been taken in connection with sinking shafts in this country during recent years, is the introduction of the process for cementing water-bearing seams encountered in the sinking. Although the process has been used in a rather similar form in Germany, no reports show that its practice has extended to the grouting of comparatively small water-bearing fissures, with the idea of making practically dry shafts. In general it has been used there only when huge flows have been encountered and exceptionally great expense for pumping has been forced on the operator.

The process as actually used here, is one of forcing Portland cement grout into holes drilled in the bottom of the shaft, the cement and water being mixed in an air-stirred grout tank which is connected directly to the compressed-air supply on one side and to the hole to be grouted on the other. In view of the wonderful possibilities that the process offers for saving money, a brief description of the method as it would be used in the sinking of mine shafts should be of interest to those who have shafts to sink or to those who for years have been pumping water from the bottoms of wet shafts. To the latter, the advantages of the process will probably appeal most strongly.

DESCRIPTION OF METHODS.

Sinking is started in the usual manner. As soon as the drills "cut" water, preparations are made for grouting. The air line which is used for drilling is run close to the bottom of the shaft for connection to the grout tank. The drilling is continued until the longest length of steel used is run into the holes. Then the drills are taken out of the shaft and a small specially shaped pipe nipple, wrapped about its enlarged portion with flannel or burlap, is driven tightly into one of the holes.

To this nipple is connected a piece of high pressure hose that leads to the grout tank on the floor of the shaft. This tank is made of boiler plate, has about 4 cu. ft. capacity and is similar in shape to an upright air receiver on legs. As shown in Fig. 1, there are pipe connections for air at the top and bottom and a connection for the discharge of the grout. The sand, cement and water, which are admitted through a small opening at the top, are mixed into a grout by the stirring and bubbling effect of compressed air admitted at low pressure through the bottom inlet pipe. The only construction in the tank that aids the air in mixing the grout, is a steel grating placed midway between the top and bottom air connections.

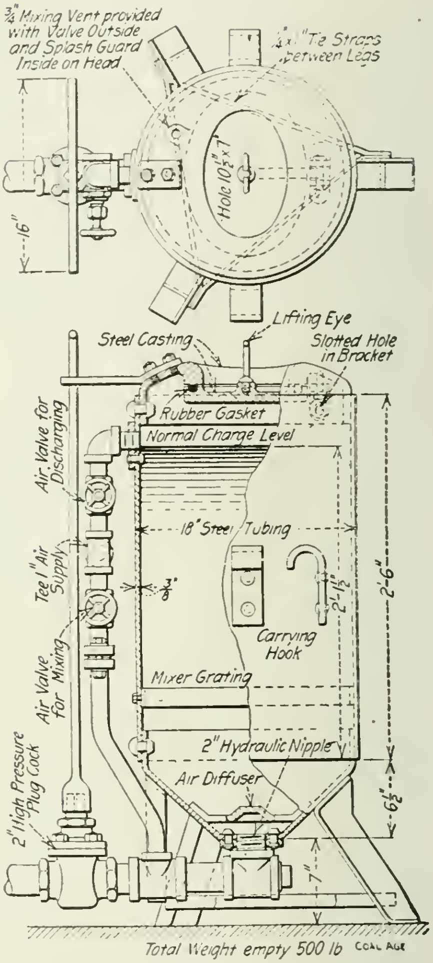


FIG. 1.

At the bottom of the tank and opposite to the lower air connection is the pipe way for leading the grout to the drilled holes. Just before the grouting is started, the drill hole is cleaned by pumping, if it is merely a running hole; if the hole is a spouter it will practically clean itself.

FORCING IN THE GROUT.

The pipes are then connected to the nipple in the hole, the batch is put into the tank and air at low pressure is admitted through the bottom connection, for stirring purposes. Next, the tank door and all plug cocks are closed except one which admits air for running up the pressure in the tank to the desired mark. The plug cocks in the discharge line are then opened and the grout is forced into the hole and into all the crevices leading to the hole. The holes are grouted to refusal; that is, until the gage shows by the rise of pressure that all crevices connecting with the hole are filled. The plug cock nearest the tank is then opened and the charge wasted. The other plug cock, immediately above the hole, is next closed, the grout hose disconnected from above the valve and the tank and pipes cleaned by blowing out. The apparatus is then connected to another hole.

If the grout from the first hole is seen bubbling up in other holes, they are immediately plugged. Such bubbling shows, of courese, that fissures are connecting the several holes. The one grouting connection will in this case serve for all the holes in which the grout is seen. If the grout is seen to rise through crevices in the floor of the shaft, a different method of procedure is required. It is necessary to place over the floor of the shaft a reinforced concrete mattresses which is allowed to set for a couple of days. Holes are then drilled through this mattress, just as if it were a shaft bottom, and the grouting process is continued as before.

At first, the drill holes are placed over the shaft bottom just as they are spaced for shooting, and the grout tank is connected to every hole that shows water. The grout is allowed to set for about 8 hours and after this, test holes, deeper than the regular round, are placed along the rib. If these show water, they are grouted and additional test holes are drilled until no water rises from the rock. The shaft is then again drilled for shooting, the number of side holes being increased so as to cut the rib as clean as possible and keep the grouted seams solid. In the regular process of sinking the shaft, the sump is then fired and mucked. The grout will appear in the crevices it has filled, like a white fine-grained sand stone. In one instance, a section of a gneiss rib, so treated, appeared as a prominently white-streaked dark marble. The benches are then fired and sinking resumed in the usual manner until more water is "cut," when the process is repeated.

PRESSURES REQUIRED FOR GROUTING.

The pressure required to grout a hole is dependent on the pressure of the water coming from the hole, because the grout must take the place of the water. Theoretically the application of this process is limited only by the pressure that the air compressor can develop and the air connections can withstand. The height that the water reaches as it spouts from the drilled hole is an accurate indicator of the least air pressure that will be required but the pressure actually used will be often much greater than indicated by this head, in order that the most minute crevices may be plugged.

However, when using high pressure every precaution must be taken against blowing out the nipples and breaking the connections. In one case, described later, it was actually necessary to drill the rock and insert wedge bolts to chain down the pipe connections to the holes. The water and sand spouted from these holes with such force that a 2-in. plank, placed over the hole to deflect the water, was in one case completely bored through in about two minutes. While drilling one of these holes, a 10-ft. steel dropped down the bore when it struck a stratum of sandy disintegrated gneiss that was later found to be producing the water. In a few minutes the steel was seen to shoot out of the hole and some distance up the shaft with a stream of sand and water behind it.

RECENT GROUTING OPERATIONS.

In sinking the No. 4 shaft of the city tunnel for the Catskill Aqueduct in New York, a stream of water was encountered at a depth of 149 ft. As soon as the drills struck the water the contractor decided to attempt to cut off the flow by plugging the crevices with cement grout. Anyone familiar with shaft sinking knows of the many difficulties of pumping, and in round shafts such as are the large majority on this Aqueduct, the troubles are more than doubled because of the general practice of drilling the entire round on one shift. The handling of a pump at the bottom of a round shaft for only 30 gal. of water per min. means a loss of at least 5 ft. of sinking per week. It was of advantage then, both to the city which paid for the pumping and to the contractor as an aid to his speed that the water bearing fissures should be grouted if possible. Accordingly a grout machine of the Caniff patent type was procured and taken down the shaft for connection to the holes showing water. Only two days were lost in completely sealing off the flow and the sinking was resumed.

However, on Oct. 28, at a depth of 183 ft., the drills "cut" a stream of such high pressure that while there was no loss of time in deciding what methods to pursue, there was, and still is, considerable speculation as to its cause. A gage placed on one of the drill holes registered 65 lb. and it required but a moment to figure that the water was coming from near the rock surface. The shaft is situated within 100 ft. of the Jerome Park reservoir and within a few hundred feet of the Croton Aqueduct. Shooting into the water under such pressure seemed suicide and as later developed, the shaft would probably have been "drowned out" had it been attempted.

It was decided to provide a high pressure grout machine with high pressure fittings. As previously noted it is essential that the grout be forced into even the finest crevices, and when it is known that over 300 lb. pressure was used on some of the holes—335 lb. on one of them—the effectiveness of the work can be appreciated. Nevertheless test hole after test hole was drilled and still the water persisted in appearing. Finally a complete ring of holes was drilled around the periphery of the shaft, the holes being kept close together. These were grouted and the cut and side holes fired. The water pressure had decreased considerably but a new condition appeared.

A CONCRETE MATTRESS USED.

The bottom of the sump was soft and sandy and soon proved to be badly disintegrated gneiss, an unusual occurrence, surrounded as it was by the hardest kind of material. Attempts to grout off the water in this sandy structure failed at first because the grout would bubble to the surface and allow but little pressure to be put into the holes. It was finally found necessary to cover the whole shaft bottom with a reinforced concrete mattress as shown in Fig. 2. The concrete was placed on corrugated iron to allow drainage to an 8 in. pipe that was stood upright in the center of the shaft to carry the pump suction while the concrete was setting. Holes were then drilled through the mattress and down into the rock and attempts made to grout.

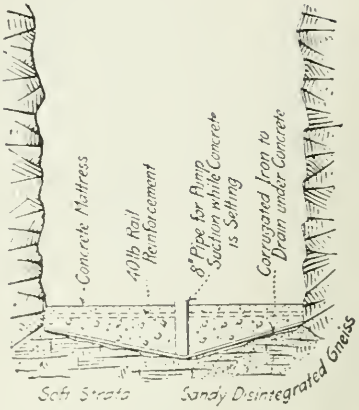

Concrete Mattress
40lb Rail Reinforcement
8" Pipe for Pump Suction while Concrete is Setting
Corrugated Iron to Drain under Concrete
Soft Strata
Sandy Disintegrated Gneiss

FIG. 2.

The flow was decreased considerably but not entirely. The reason for this became clear when the concrete was removed and the rock shot up. Pieces of the grout, shaped precisely like a diamond drill core, were found in the muck with clumps of cemented sand clinging to them. Clean, or even fairly clean, crevices were grouted perfectly, but strata of sand were only matted in spots and it was from these strata that the remaining water was coming. Sinking was then continued for about 20 ft. and the regular concrete lining of the shaft was started.

The shaft was enlarged through the soft sandy strata so as to permit ample drainage channels behind a heavier-than-usual reinforced concrete lining. Grout pipes were run from the inside face of the lining back to these drainage channels. These pipes carried the water through the lining into the shaft and, after the concrete had set for a week or so, they were closed with ordinary plugs, thus completely shutting off the entire flow. Later, these plugs were removed and grout was forced in behind the lining to fill the drainage channels.

ADVANTAGES TO THE MINE OPERATOR IN OBTAINING DRY SHAFTS.

The fact that the problem of dealing with the water encountered in sinking a shaft has met with a new and effectual solution, marks a big step forward, but by all odds the greatest advantage of the grouting process is the saving of money that the mine owner would otherwise have to spend year after year in pumping the water of a wet shaft. The cost of pumping 200 gal. of water per minute from the bottom of a mine shaft 500 ft. deep is easily figured. This is probably an average quantity for a shaft of that depth and will require about 25 water horsepower. Taking as a basis a direct acting pump using 90 lbs. of steam per horsepower hour it is readily figured that 75 boiler horsepower are required. A horsepower will cost the mine operator about $20.00 per year and $1500.00 per year will be the total expense for pumping the shaft water.

Grouting with cement and sand as the shaft is being sunk will save this expense and, under ordinary conditions, crevices that will produce a flow of 200 gal. per minute, can be grouted solid for much less than a year's cost for pumping. With successful grouting, no water rings will be required and so the actual increase of first cost to the mine operator will be small. The idea is new in this country and the method as it has been described here is entirely new to shaft sinking practice. It has proved a success in every instance that it has been tried of late, and engineers who have studied the operation pronounce the shaft water problem solved.—*Coal Age.*

LOSS BY SAVING AIR

To the student of combustion the perplexing question always is why coal users will continue to burn expensive coal and freight money when air is so cheap and makes a hotter fire? To suggest burning air seems like fathering one of those altruistic dreams which occasionally are inflicted upon the public. However, it is sound in principle and is the one thing really worth considering.

To illustrate what we mean: There is coming into use generally, in construction work, concrete or stucco. To make a first-class stucco requires one part of cement, three parts of sand and five parts of gravel. Sometimes the mixture is one, four and six respectively. Any man knowing that the first mixture is strong, would call the contractor insane who insisted upon using the expensive cement alone.

At the same time, to get proper combustion means a mixture of one part of coal and twelve to eighteen parts of air. It is just as foolish for a man who burns coal to think of getting the best results by using coal alone or with a very small amount of air as it is to build a house out of cement alone. Twelve parts of air to one part of coal will make a fire so hot that very few furnaces or grate bars will stand up against it. A mixture of eighteen parts of air with one part of coal will make, commercially, an economical and hot fire.

When air is so cheap and has such a tremendous influence upon coal combustion, we constantly wonder why men will try to burn coal without air and why the nation keeps on paying unnecessary millions of money each year for fuel when it could save those millions by simply forcing air into the fire box.—*Black Diamond.*

DANGER OF SPRAYING TO ALLAY DUST

To avoid the danger of causing an epidemic of hookworm disease through the sprinkling of mines, it is necessary to mix various substances in the water such as salt, calcium chloride, or ferrous sulphate. A 1 per cent. solution of ferrous sulphate or a 2½ per cent. solution of salt is quite strong enough. These solutions keep the roads damp for a longer time than water alone. The efficacy of the salt solution was proved in the Dolcoath epidemic, where the only mine unaffected was one where a considerable quantity of sea water came into the mine, and in mines on the Continent calcium chloride or ferrous sulphate have proved efficacious.

OXYGEN CONSUMED BY A LAMP

The most recent tests to show the oxygen-consuming power of a naked flame are some experiments in Scotland. A lamp burning oil consumed 1.13 cu. ft. of oxygen and produced 0.78 cu. ft. of carbonic acid per hour. The same lamp when burning tallow consumed 2.49 cu. ft. of oxygen and gave off 1.74 cu. ft. of carbonic acid in one hour. The investigators determined the candlepower of various lamps by photometry. An old lamp (naked flame) consuming 13.8 gms. of oil per hour averaged 1 cp. The kind of oil used, of course, affects the candlepower considerably. A miner's tallow lamp consuming 17.4 gms. of tallow per hour averaged, with uniform flame for 15 minutes, 2.3 cp. A lamp consuming 13 gms. paraffin wax per hour gave 1.6 cp.

PNEUMATIC APPLIANCES IN RAILROAD SHOPS

Mr. F. A. Stanley, "Western" Editor of the American Machinist, is making a remarkable record in writing up in detail the machine tool equipment of various shops visited in his territory. Perhaps one of the most valuable and interesting of the notable series of articles he has thus far produced was in the issue of March 7 and was devoted almost exclusively to pneumatically operated tools in the so-called "Katy" shops of the Missouri, Kansas & Texas Railway at Parsons, Kansas. The tools described are practically all of local design and construction and they suggest how in railroad shops more than in any others compressed air is constantly thought of when things are to be done and finds unlimited variety of employment. The article spoken of wastes no words but goes right at work with views and descriptions only selected portions of which we here reproduce.

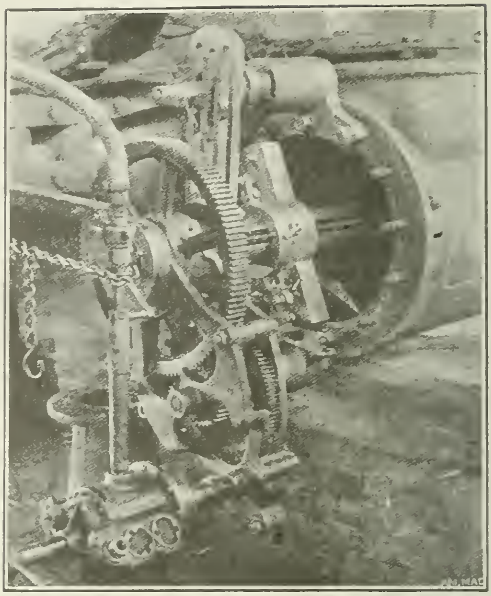


FIG. 1.

The devices shown are many of them portable, Fig. 1, showing a boring bar for reboring locomotive cylinders without removing them from the engine. The bar is mounted in bearings hung from brackets secured to the cylinder studs and the drive from the air-drill motor is transmitted through spur gears giving the desired speed reduction. The cutter head is fed along the bar by a screw with star feed.

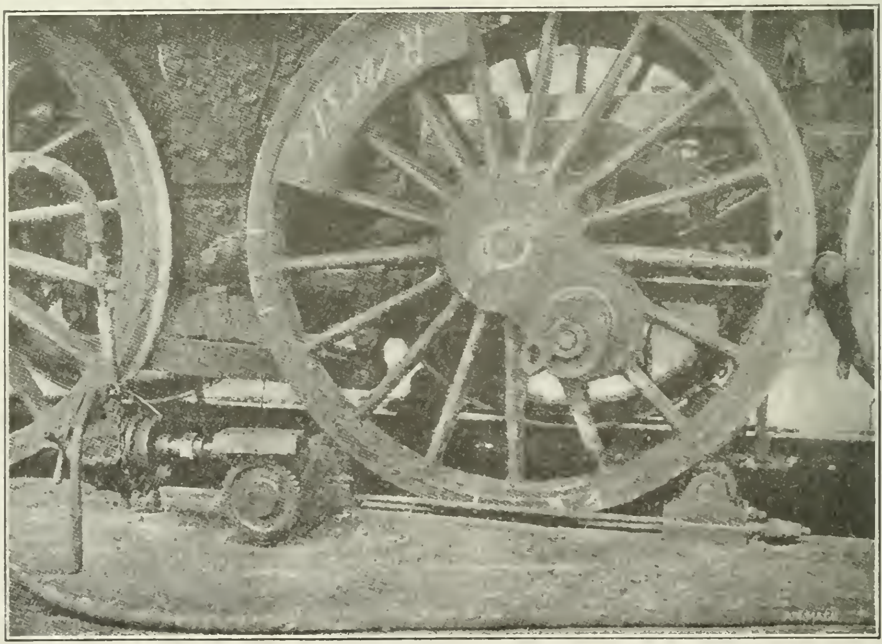


FIG. 2.

Upon the same cylinder even while the boring was in progress another air driven tool described in the article might be used for milling out the steam ports on the valve seat.

TURNING-OVER FOR VALVE SETTING.

One of the most tedious operations in the railroad shop, though not of daily occurrence, is the turning over of the driving wheels for the purpose of setting the valves. Before the entire valve motion is satisfactorily adjusted much time and labor are wasted if only human muscles are employed. The apparatus shown in Fig. 2 is the means of relief provided in the "Katy" shops. The rig consists of two pairs of small rolls carried by blocks which are placed in contact with opposite sides of the drivers and then drawn together by through bolts to lift the pair of wheels from the track. One of the rolls is corrugated and is carried on the end of a wormwheel shaft which is driven by a worm connected to an air-drill spindle as clearly shown. The corrugated roll thus serves as a medium for rotating the driving wheels, the three other rolls acting merely as supporting idlers. The wormwheel shaft has roller bearings at each end, made up of ⅜-in. rollers of soft steel, operating in a case-hardend bushing.

PNEUMATIC CLAMPS FOR DRILLERS.

Fig. 3 shows a handy attachment applied to drillers of various sizes for holding the work without loss of time in fastening and releasing the piece.

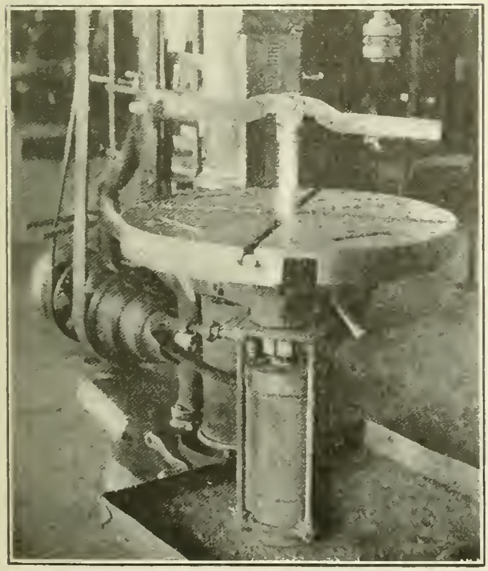


FIG. 3.

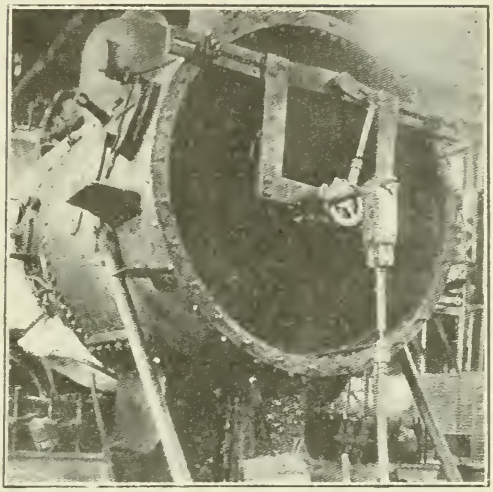


FIG. 4.

The air cylinder under this drill table has a 6-in. bore and the stroke is 8-in. The piston rod extends up through the center of the table and is forked at its upper end to carry a long clamp bar which is pivoted at the center. The piston and clamp are lifted to release the work by a heavy spring between the underside of the piston and the bottom of the cylinder. The work is clamped by air pressure upon the upper side of the piston.

OSCILLATING MACHINE FOR GRINDING-IN PIPE.

The appliance in Fig. 4 was constructed for grinding dry-pipes into flue sheets. The rotary motion of the air-drill spindle is transmitted by an eccentric to a rocker arm which oscillates a horizontal shaft extending inward to the pipe and carrying three radially placed pointed jack screws which are set up tight inside the mouth of the pipe. The screw points engage the pipe hard enough to cause the latter to turn to and fro with the oscillations of the rock shaft and the pipe is thus ground in to a tight seat in the flue sheet.

A HANDY TRAVELING DRILL.

The outfit in Fig. 5 forms a very convenient equipment for such work as the drilling of test holes in stay-bolts in boilers and for other operations where a lateral movement of the whole driller is desirable. The engraving represents the drill proper mounted in a metal

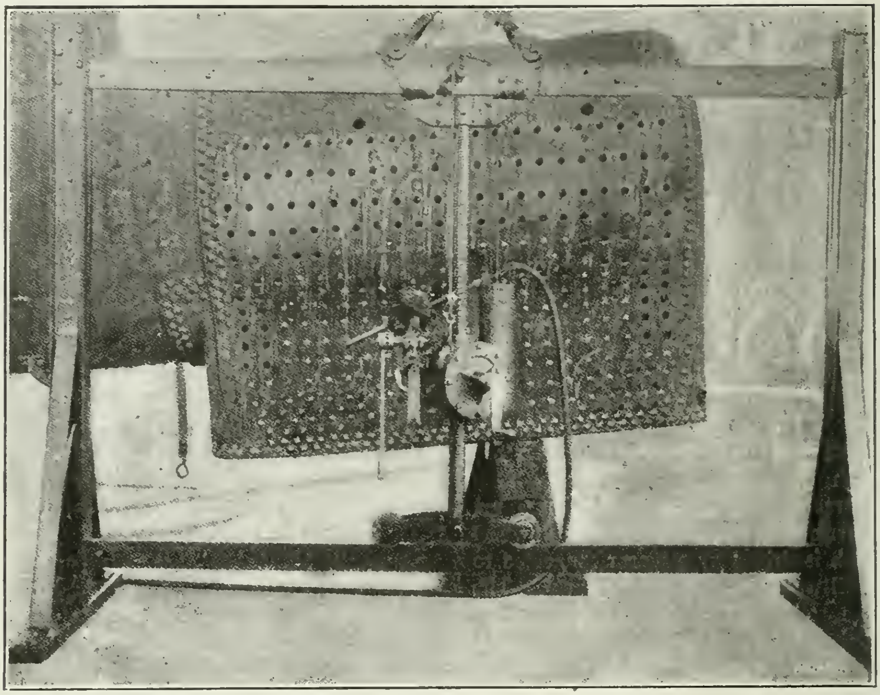


FIG. 5.

frame which provides upper and lower tracks for it to travel on over a distance of eight or ten feet. The whole affair may be picked up by the crane and moved to any desired point in the shop. The air drill is mounted at the end of a stiff shaft which is slid in its bearings by rack and pinion to feed the drill to the work and withdraw it for the next operation. The guide for this drill carrier is adjustably attached to a body which is mounted upon the threaded upright forming the driller column. Adjustment up and down the column is secured by a crank handle. The head is balanced by the counterweight shown. The drill is adjustable in every direction and is readily clamped at the necessary angle for any hole to be drilled.

ATTACHMENT FOR PNEUMATIC CHISEL.

The pneumatic chipping hammer in Fig. 6 is fitted up for cutting off stay-bolts in boiler work. As illustrated it is equipped with an attachment for holding a back jaw or anvil cut off with the chisel. In operation, the

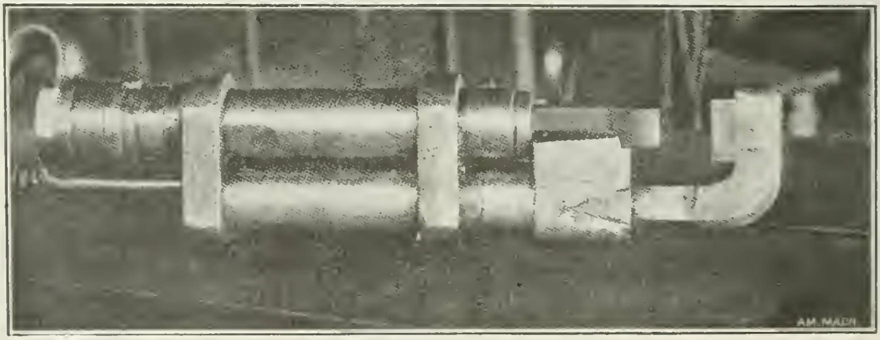


FIG. 6.

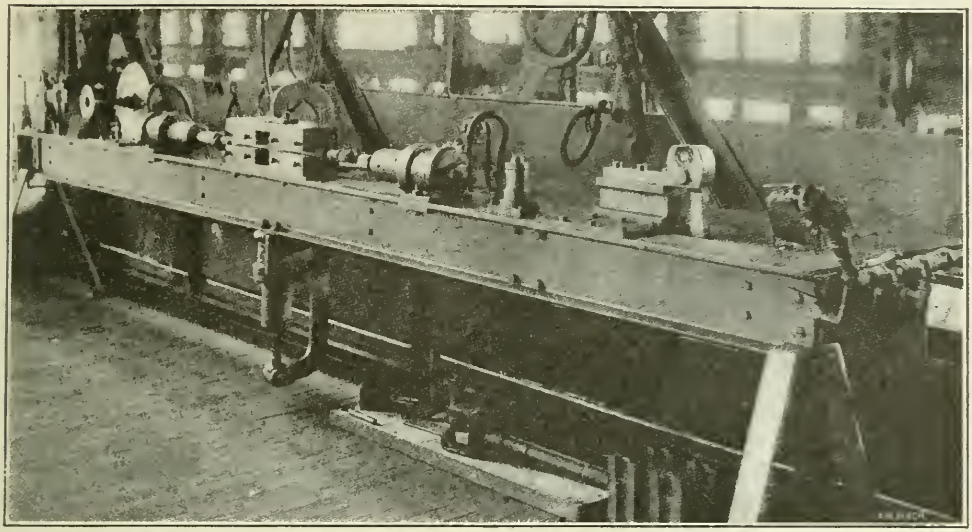


FIG. 7.

which is drawn up against the stay-bolt to be piece is cut nearly through with the chisel and then broken off with a blow of a hammer.

AIR HOSE TOOLS.

The view in Fig 7 shows a portion of the pneumatically operated equipment in the air-hose department. At the right-hand end of the bench there is a pair of cutting jaws for shearing the heads from rivets in the hose clamps. The hose is afterward split to release the coupling in the machine at the left end of the bench. Here the hose is placed in a V-block and the splitting chisel brought down to cut the end free from the connection.

The machine near the left end of the bench resembling a horizontal fan is a rotary internal wire brush into which the couplings as removed from the old hose are slipped for the removal of dirt and scale, this process fitting them for assembling in the new lengths of hose.

The apparatus at the center of the bench consists of a long vise in which the hose is gripped, and two air cylinders at the ends which supply pressure for forcing the connections into the two ends.

HANDLING SHEET METAL WORK.

The two machines in Figs. 8 and 9 are pneumatic punch presses for sheet-metal operations. The one in Fig. 8 carries sixteen 3-16 in. punches for piercing as many holes at each stroke in locomotive jackets of Russia iron The other press pierces and blanks out a body for a tin torch.

In both cases the rams with the punches are operated by a pair of rocker arms connected by toggles with the air piston. It will be seen that the effect of this arrangement is to produce a complete down stroke and return stroke of the punch by a single stroke of

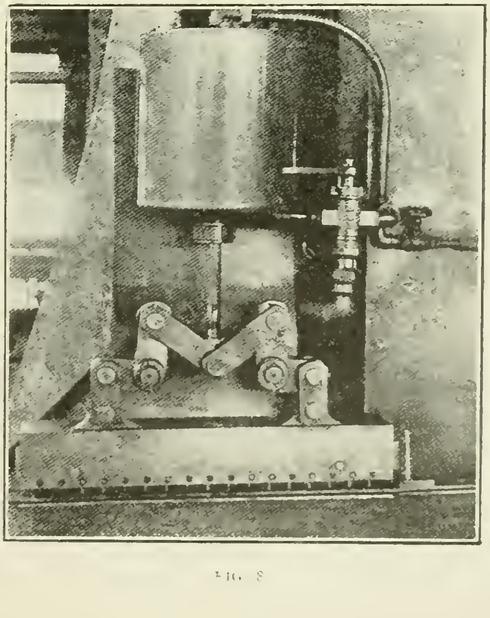


FIG. 8

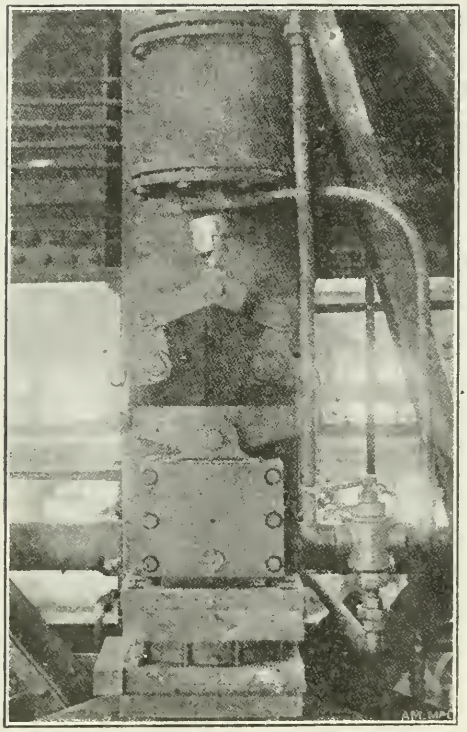


FIG 9.

the piston in either direction. That is, as the piston descends the punch is forced through the work and then withdrawn. When the piston lifts, the punch is again moved through its down and up strokes. The range of movement is, of course, quite limited, but it is sufficient for the special work for which the apparatus was constructed. These air-operated presses are placed along the gallery structure where they occupy very little space that could otherwise be utilized by machinery, and they are found highly satisfactory for the classes of work for which they were built.

Three or four other pneumatic devices in the "Katy" shops have to do with the heavy leaf-springs employed in railroad construction. One is for placing the bands on the middle of the springs to hold them together, and another is for removing these bands. Still another device is for pulling down tank-truck springs to enable the through-bolts to be put into place. There are of course many other special air operated devices in the shops besides the regular line of pneumatic tools.

SMALL TUNNEL DRILLING AND BLASTING

An important change in the tunnel system of Rochester, N. Y., involved the construction of about a mile and a half of tunnels in solid rock with a 6 by 6 foot section. The tunnel work is described in a recent issue of *The Contractor* from whose columns we reproduce the following.

When the tunnel excavation was started from fourteen to sixteen, 8 to 10 foot holes were drilled in the 6x6 foot tunnel. Two Ingersoll-Rand air drills, mounted on columns, were used for this purpose. The holes were charged with dynamite and fired with a battery. About eight hours were consumed in drilling the holes, and two or three hours and occasionally longer in the blasting and waiting for the fumes of the explosive to blow away. A great deal of trouble was experienced with the explosives and their fumes, and considerable time was lost due to this. Although three shifts were worked, only two rounds of holes could be drilled and fired in twenty-four hours.

In order to improve on this, experiments were first made to procure a good high power gelatine dynamite, that would nominally be without fumes, the contractors realizing that considerable time could be saved in this way and some money. The Nitro Powder Company's special tunnel gelatine was adopted. It might be stated that all the so-called fumeless powders have some fumes when exploded, and it is always a matter of selecting the one with the least fumes. The less fumes emitted by a powder means a more effective blasting compound as the gas is used up in effective work, instead of being thrown off in the surrounding air, thus making the explosive quick and more powerful in its action.

Investigation was also made as to arrangement of drilling and firing holes. With a more powerful explosive fewer holes were needed, so what is known as the Hammer Cut method, used extensively in the western mines, was introduced. With this method only eight to ten holes were necessary, which allowed the drilling to be done with one of the Ingersoll-Rand drills, thus saving two men on a shift. The work being done to a great extent as a task, the foremen could be dispensed with, and instead, day and night blasters were employed.

In place of firing the holes by battery and exploding all of them simultaneously, fuse was used. There are a number of disadvantages in driving small tunnels and headings and using a battery to explode the charges. When a battery is used, the number of holes drilled are from fourteen to sixteen and are so close in some tunnels that they must be fired simultaneously, otherwise one hole may rob the others. In the east, in a 6x6-foot tunnel or heading, the holes are often fired in three series. First, the center holes are shot, then there is a wait until the fumes and gases can be blown out, so that a man can go into the tunnel and connect up the wires to blow out the rib holes, after which there is another wait while air is blown in, and finally the breaking down or back holes are exploded. Thus three blasts are made to break about six feet of ground. Naturally, each charge exploding makes a dense volume of smoke that hangs as a body at the breast, making it necessary to blow out the smoke and fumes to allow a man to enter to make the next blast. If the tunnel is long or the work is in a confined space the time thus lost is considerable and the delay is not only to the blasters, but also to the drillers and muckers.

By the Hammer Cut method, where fuse is used, as previously stated, the number of holes is less, thus the drilling cost per cubic yard or per lineal foot of tunnel is nearly cut in half. The cost of loading and the cost of explosives is decreased. This is so, because the holes can be located and drilled differently. The rib holes can be entirely eliminated. As a rule, there are only needed three cutting holes, two or three lifting holes, two or three breaking down holes, and two back holes, in all from eight to ten holes; seldom more than ten and under favorable circumstances only eight.

When fuse is used, all the holes are lighted at one time, so that it is not necessary to enter the tunnel until the entire blast is over. In order to obtain the best results from the drilling and explosives, the different holes are exploded one after the other. This is accomplished by cutting each fuse to a different length, so that No. 1 hole is exploded first, No. 2 second, and so on through the eight or ten holes. If it is desired to explode two or more holes, as the cut holes at one time, the same length of fuse is used for each hole as two or more fuses located close to each other can be lighted by an experienced man in a few seconds. Each hole is given a number, the same length fuse used in the same numbered hole each time, and they are all lighted in the same order.

An experienced man is able to count the explosions and if one hole misses fire, he is able to locate it at once. This is not possible when all the holes are shot simultaneously or in series by a battery. Then, too, the concussion of the successive blasts, when fuse is used, helps to drive out the smoke and fuse, so that when the blasting is finished, the tunnel air is purified much quicker by means of the air pipes.

Sometimes in soft and seamy ground the seams will connect up part or all of the holes and the entire set of holes will explode simultaneously or at other times one hole will rob another or blow the charge out of an adjoining hole, and the dynamite will be found scattered around the heading. The experienced blaster will be able to tell these things by the reports of the blasts, and will exercise care in entering the tunnel, and if such seams continue, steps can be taken to prevent these things.

With fuse there is no danger to the man firing, and one man should do this, if possible. Good fuse burns at the rate of one foot in forty seconds, so that a piece ten feet long gives a man about seven minutes to light the fuse and get out of the way. The best evidence that there is no danger is that accidents do not happen in this way.

Another advantage in fuse blasting is that the cutting holes are blown first, throwing the muck well out in the tunnel, and then the breaking down holes exploding, throw their muck down and out, while at last comes the lifting holes, throwing the muck well out on the rest, thus nominally clearing the bottom so as to allow the drill column to be set up at once, and the pile of muck immediately behind the driller (gives him something to stand on, without time placing a scaffold) while he is drilling the upper holes, which for this reason should be drilled first. Then, as the muck is cleared away, the bottom or lifting holes are drilled.

The method described above was the one used by the contractors and they found that they broke as much ground as with the former method. The location of the holes and the mode of lighting the fuse is shown in an accompanying cut. During the eight months that this method has been in use, the contractors have not even had a minor accident. Not only have savings been effected in time lost by fumes, in labor, number of holes drilled, dynamite, air, and in other ways, but in as much as the concussion from blasting of one hole is much less than when the holes were fired in series, no damage has been done to adjoining property.

The sixty per cent. Nitro gelatine, put up in 1⅛-inch sticks, was stored in magazines, that were heated by small boilers, which supplied heat to radiators that were properly protected. Thus, during the winter weather the dynamite was thoroughly thawed at all times, so that the best results were always obtained from it. The writer has seen dynamite used that was supposed to be thawed, when large chunks of it were not, and these did not explode, or a frozen core not much larger than a lead pencil would be found in the sticks. Thus the full power is not obtained and so money is wasted

Another feature of interest is the use of electricity on this work, thus eliminating many boilers, much smoke and labor. The Ingersoll Rand air compressor is electrically driven, and the tunnels are kept dry by Cameron pumps. At some of the shafts air hoists were used.

APPLICATIONS OF PNEUMATIC TOOLS

BY A. M. M.

There are many classes of work now done by hand to which pneumatic tools can be applied with advantage. Many plants have developed special uses for these tools, a few of which are here presented.

A contractor engaged in erecting large electric generators had several thousand tubular rivets, 1½ inch in diameter, which were to be headed cold. This was a very slow and laborious job. The rivets were used to hold together the laminations of the stator, and were drilled at the ends to make them tubular and to facilitate heading. By means of a beading tool and a hand-hammer, they could be riveted up in the same manner that boiler tubes are beaded, but it was found that not more than two per hour could be headed by hand. After considerable experimenting a 9-inch pneumatic riveter was fitted with a special die for the work, and the time was reduced to five minutes per head, with less fatigue to the operator.

Fig. 1, showing the die and rivet end, illustrates the idea. A common riveting die was turned to fit the finished head leaving a centering pin in the middle of the die. Two opposite sides of the die were then slabbed off on a milling machine, leaving the working edge about ⅜ inch. thick. This edge was filed round, and the die hardened. A hole drilled through the die provided means for attaching a piece of ⅜-inch round steel wire as shown. This served as a handle to rotate the die. The operator could form a perfect head on the bolt by slowly rotating the die, and working down the edges as desired.

DRIVING DRIFT-BOLTS IN CRIB WORK.

A contractor was building crib work of hard fine timbers, 10 inches square. He had several thousand drift-bolts to drive. The bolts were 8 feet long, and 1 inch in diameter. He had several gangs of three men each working from a staging, driving with heavy sledges. The three men would drive one bolt, striking alternately. The work was progressing so slowly that he determined to try a pneumatic riveting hammer. He found that a heavy riveter, operated by one man, would do the work of two gangs (six men), and dispense with the heavy staging.

PNEUMATIC HAMMER IN BROACHING OPERATION.

A machine shop had a large number of hexagon bushings whose inside surfaces had to be finished smooth and of accurate dimensions to make a close fit on a ¾ inch hexagon rod. A hexagon broach of the same dimensions as the rod was machined and the end squared off to a cutting edge. It was found very difficult to drive this tool through the bushing with a hand hammer, but it was easily and quickly accomplished by the rapid blows of a pneumatic hammer.

A PNEUMATIC WOOD-CUTTING TOOL.

It often happens that wooden hatches or decks are fitted with I-bolts or handles which must lie flat with the surface. To make room for the fingers or a rope under the ring, the wood must be cut out in the form of a cup or depression. Often, on a large job, there will be several hundreds of these cups to hollow out of the flat surface. A carpenter with his gouge and mallet will take a couple of hours to finish one, but the cutter here described, fitted to a pneumatic machine, will do this work in a few minutes. The cutter blade is formed of ¼-inch tool steel plate, set into a slotted bar and brazed. After this operation is completed, a block of wood, turned in a wood lathe to the shape of the cup, is fitted to it as shown in Fig. 2. This block allows the cutter to project beyond its surface, and prevents it from taking too large a chip. The tool works best in one of the smaller machines of high speed. A ¾-inch guide hole is first bored to the required depth.

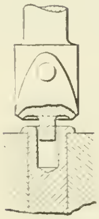


Fig. 1

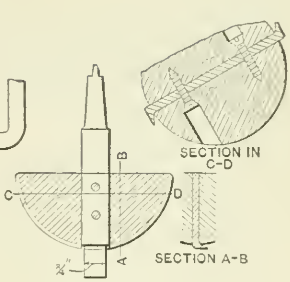


Fig. 2

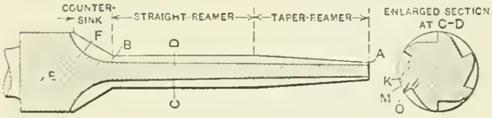


Fig. 3.

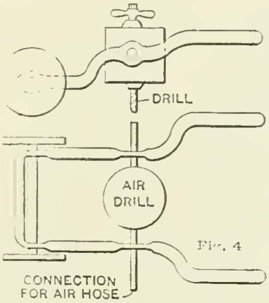


Fig. 4

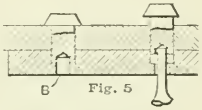


Fig. 5

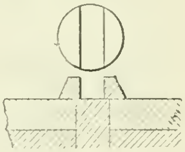


Fig. 6

APPLICATIONS OF PNEUMATIC TOOLS.

SPECIAL REAMERS FOR PNEUMATIC TOOLS.

In a plant handling structural or steel ship work, the reaming and countersinking of the thousands of rivet holes is a large item, and may represent a considerable percentage of the cost of construction. It is important that the reamer with which this work is done shall have certain properties. It must cut rapidly, without heating. It must clear itself when forced, without breaking. It must stand the abuse of unskilled labor. Two men with an ample supply of sharp correctly made reamers will ream several thousand holes per day, where they will only ream several hundred if obliged to work with reamers which do not cut properly. The following description and illustration, Fig. 3, shows how one of the large shipyards increased the efficiency of this operation several hundred per cent. by giving careful attention to these points.

This yard had a million, more or less, ¾-inch rivet holes to be reamed and countersunk. The work was started with the ordinary pneumatic reamers and countersinks, making two separate operations. The tool-room, having only a small supply of these tools and having other troubles, was very "economical" in handing out reamers, and kept the men working with the tools long after they were too dull to cut properly. The consequence was that the men would keep a reamer turning in one hole for several minutes, and not only did it not work, but the reamers were burned. The men made no attempt to rush the work as this only resulted in burned reamers and a "call-down" from the tool-room.

The following system was adopted with an increase of about 500 per cent. in the amount of work turned out. A special combination reamer and countersink was designed as shown in Fig. 3. Enough of these tools were provided to allow about four reamers per gang. The gangs were put on piecework and one skilled operator in the tool room was made responsible for keeping the reamers sharp. Each gang was given a can of tallow on which to lubricate the reamer as often as required.

A "WHEELBARROW" DRILL MOUNTING.

The gangs working on the flat decks were cut down to one man, and this man was provided with one of the wheelbarrow devices shown in Fig. 4 in place of his helper. The countersink reamers insure that the countersink will be concentric with the reamed hole, and the whole job is done at one operation.

CUTTING OUT RIVETS

An easy way of cutting out countersunk rivets is as follows: First drill a hole as shown in Fig. 5 at *B*. Then use a backing-out punch made to fit a pneumatic riveting hammer. If a good backing is available, a pneumatic "jam hammer" can be used to advantage. For cutting off rivet heads proceed as in Fig. 6, using a pneumatic chipping hammer and "cape" chisel. First cut a slot through the head making it like a slotted screwhead. The two sides can then be cut off without trouble. Adapted from *Machinery*.

VARIOUS PNEUMATIC DEVICES

In the cut upon the opposite page are collected a number of pneumatic devices which have recently appeared in our exchanges.

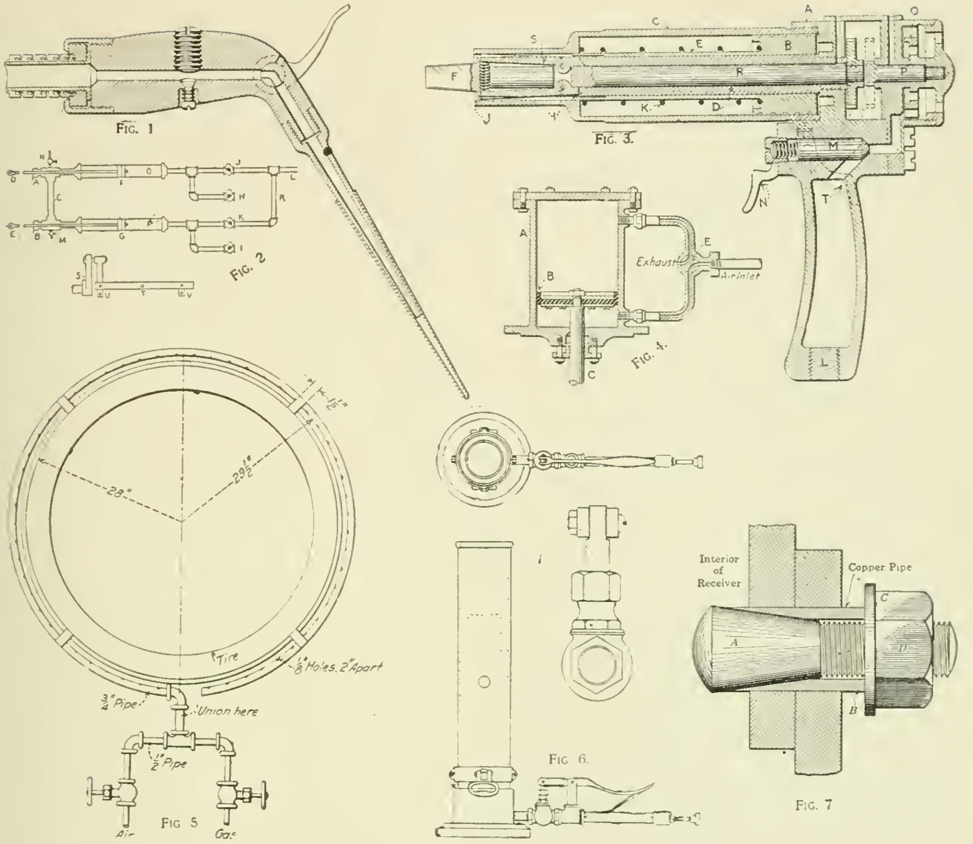
Fig. 1, from *American Machinist,* may be called a vacuum pick-up. In manufacturing jewelry and miniature marquetry work known as "articles de Paris" there is sometimes a quantity of small light parts of ivory, gold, silver or wood to be handled that are so thin that pincers may spoil them. A very handy way to pick them one by one without deformation is to use vacuum. For infrequent service a rubber bulb as used by photographers, provided with a tubular nozzle, is sufficient. But for regular work the following arrangement has been found satisfactory. A small electrically driven blower is used to create 6 to 10 inches of water vacuum in suitable piping. An armored rubber tube connects to the nozzles provided with a three-way cock. By pushing the cock handle, air is pumped through the nozzle and by having the latter of suitable size, pieces as small as 1-32x1-32x0.001 inch of silver can be handled. Pulling the handle breaks the vacuum in the nozzle and the piece is free. For such small pieces as mentioned above, 6-inch vacuum is too much to allow them to be picked up one by one from the pile in the right position; hence, the small valve in the handle is added to regulate aspiration while separating the points. The nozzle is made large enough to accommodate the largest pieces to be handled, and several adapters are provided; these being simply tubes fitting the nozzle and having various sizes of holes.

A HOME MADE AIR COMPRESSOR.

Fig. 2, from Popular Mechanics, shows a cheap and quickly made air compressor which might serve for experimental or temporary service. It will produce some 50 lb. pressure in a tank and is made with two cast iron open well pump cylinders, $2\frac{1}{2}$ in. inside diameter, and common pipe connections. These cylinders can be purchased cheaply, complete, including guide rods and plungers. Packing boxes, A and B, from old discarded valves are fastened into the tee connections on the end of the pipe C. The valve rods D and E pass through the packing boxes and are attached to a device for driving the pistons F and G. The pipe connections on the ends of the cylinders have two inlet check valves, H and I, and two outlet valves, J and K, to the pipe L attached to the tank. A crank arrangement can be fixed to operate the compressor from the end of a shaft as shown in the lower sketch. The crank S operates an arm pivoted in the center at T. The plunger ends D and E are attached to the projections U and V.

CONDENSER PACKING TOOL.

Fig. 3 from *Power,* shows a novel and ingenious device for packing condenser tubes. Operated by compressed air, it winds the packing cord around a spindle and then pushes it into position around the tube, both operations being controlled by the thumb trigger. The body part A is integral with the handle. The barrel is made with a reduced outer end, and the parts are secured by screw threads, as shown. The tubular reciprocating plunger *E* is provided with a piston *B* which accurately fits within the barrel *C*. A rotary shaft fits within the inner guide tube and is provided with an enlarged journal bearing at its outer end. The end of this enlarged part is turned down into the form of a frustum of a cone, as indicated at *F*, and is provided with a shoulder which fits against the end of the tubes around which the packing is to be inserted. This enlarged part also constitutes a cylinder around which the packing cord is wound before the tool is put into use. To secure this cord a longitudinal groove is provided in the body part in which is pivoted upon a pin *H* a longitudinal finger *J*. It is grooved at its outer end and has a spiral spring inserted in a hole, the arrangement being such that normally this finger is held at its outer end against the inner face of the small end of the barrel. The spiral spring *K* is for the purpose of returning the reciprocating plunger to its normal position after it has been actuated by the compressed air. A longitudinal slot at the small end of the barrel constitutes an opening for the insertion of the packing cord. The air supply is conducted to the handle of the tube through a rubber tube. In the bottom of the handle is an opening *L* which runs to the body of the valve where it is divided into two channels, one conveying the compressed air to the piston and the other to the driving motor. The



VARIOUS PNEUMATIC DEVICES

valve *M* is held in a seated position by a spiral spring, and the valve is actuated by means of the trigger *N*. The operative part of a rotary motor is shown at *O*. It is secured to the rear end of the breech of the tool and the shaft *P* actuates the rotating shaft *R* of the tool. A detachable cap is secured to the casing of the motor and is provided with a journal bearing. A pinion carried by the shaft *P* meshes with the gear wheel which rotates on a bearing journal that is secured to the breech. Another pinion is carried by a shaft integral with the gear wheel and meshes with a second gear wheel that is secured to the rotary shaft *R*. A second valve is kept seated by the pressure of a spring in the channel running to the rotor of the motor. This valve is operated by the lever *T* which is worked by the pressure of the thumb. Air vents are provided for liberating the air after it has passed through the motor. When using the tool one end of the cord is inserted at the outer end of a slot at the small end of the barrel. Air pressure is then admitted to the motor by merely pressing a trigger with the thumb. The motor rotates the spindle *S*, thereby drawing the cord through the opening and winding it around the spindle. The cord is then in a position to be forced on the tube end by the reciprocating plunger. The operator presses the finger trigger a number of times in succession until the cord has been driven home, the number of blows depending upon the density to be given to the packing. In this way the operator passes from one tube to another in quick succession. The average operator can easily pack a condenser at the rate of from 10 to 15 tubes per minute, and as many as 28 tubes have been packed per minute. This instrument was invented by Edward P. Strode, 131 E. 30th St., N. Y.

AIR POWER FOR STEAM VALVES.

Fig. 4 is to be regarded as merely a suggestion from a correspondent in a recent issue of *Power*. The writer says: "Most modern power plants are provided with air compressors and many of the larger valves might be operated by means of air. The sketch shows my idea of this means of application of air. The appliance consists of a cylinder *A*, bolted to the upper flange on the valve body; a piston *B*, fitted to the upper end of the valve stem *C*, which is packed, as shown and a four-way cock *E* connected by means of unions to the cylinder *A*. The illustration shows the position of the piston when taking air underneath and exhausting above the piston *B*.

LOCOMOTIVE TIRE HEATER.

Fig. 5, from *Railway Age Gazette* shows a cheap, handy and effective tire heater using gas in connection with compressed air. The circular portion is made of ¾ in. pipe, with ⅛ in. holes, spaced 2 in. apart, on the side toward the tire. There should be a sufficient number of these circular parts to take care of the different diameters of tires; it is not a good plan to open the pipe out for use with larger tires than it was intended for, as bending it back and forth soon causes it to break. The union which connects the air and gas pipes allows the ring to be detached and changed. Gas is used at a pressure of about 45 lbs. per sq. in. and air at about 75 lbs. per sq. in. In operation the piping which connects to the ring is at right angles to the position shown on the drawing.

AIR SLEDGE.

Fig. 6 is a sketch of a home-made air sledge described by Charles Markel, shop foreman, C. & N. W. R. R., Clinton, Iowa, in Railway and Locomotive Engineering. It is made of a 4-in. pipe about 2 ft. in length and operated by a globe valve furnished with a lever-operated valve, which gives quick opening to the air inlet and automatically closes by a spring attached under the handle. This sledge has proved itself to be every effective in removing refractory bolts, and is much valued by the men of the wrecking crew, as it has been very effective in removing draw-bar pins where the tender and engine were jammed together. The device has the double merit of being simple in construction and operation.

STOPPING LEAKS IN AIR RECEIVERS.

The device shown in Fig. 7, we regret to say, we are unable to credit to its source as our record of it is mislaid. A convenient method of stopping leaks around a loose rivet in air receivers or steel water tanks, or even for emergency repair work on boilers, and one which can be made entirely from the outside is to use a taper bolt with copper sleeve, as illustrated in the accompanying sketch. The head of the faulty rivet is cut off, and the rivet knocked out of the hole, or else the rivet may be drilled out. A taper bolt *A*, large enough to pass through the hole, and threaded up to 1½ in. of the large end is inserted in the rivet hole and a piece of copper pipe *B*, of the same internal diameter as the diameter of the bolt, is lipped over the threaded portion of the taper bolt; it should project ¼ to ⅜ in. on each side of the plates. A washer *C* and nut *D* are then put on and the nut screwed up with a long-handle wrench. The bolt can be used for withstanding pressures up to 200 lb. per sq. in. with safety. The bolt may be used for repairing other small leaks such as may occur in pump columns by drilling out a hole at the point where the leakage occurs. A variety of uses for such a bolt will be suggested by the sketch.

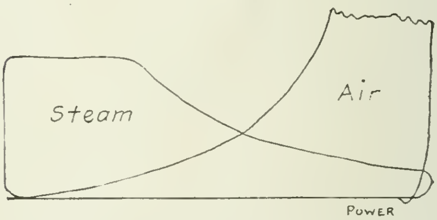
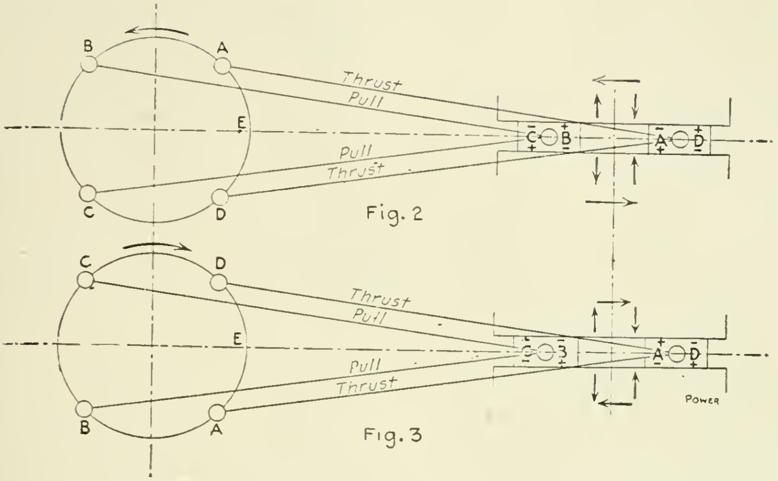


FIG. 1. COMBINED AIR AND STEAM DIAGRAM

ALTERNATING DIRECTIONS OF ACTUATING FORCES IN STRAIGHT LINE AIR COMPRESSORS

By FRANK RICHARDS.

The questions which have recently been current in the pages of Power as to the direction in which the crank shaft of a straight line air compressor should run, and also as to the peculiar knocks sometimes accompanying the crosshead movements in compressors of this type, suggest that something might be done toward the securing of a clear and final understanding of the matter, and accordingly I have prepared the accompanying layout, such as I believe has never been done before, and which I hope may help to straighten out the matter. I am aware that the thing is not of



FIGS. 2 AND 3. REPRESENTING GRAPHICALLY THE PRESSURES ON THE CROSSHEAD AND PIN

great importance—althought it is curious and interesting—and for that reason it would be well to get it out of the way.

We all know that in the horizontal steam engine if the crank shaft runs "over" the crosshead pressure is always downward, while if the crank shaft runs "under" the resultant vertically acting forces at the crosshead are reversed, and usually more than sufficient throughout the stroke to overcome the weight. In the air compressor the conditions are very different, no matter which way it runs.

In the typical combined air and steam diagram, Fig. 1, which might be from any straight line compressor, the cylinders being assumed to be of equal diameter, we see that in the earlier portion of the stroke the steam pressure is greatly in excess of the air resistance, and the surplus of the power must be disposed of in increasing the momentum of the fly wheels. At the point where the steam expansion line and the air compression line cross, the pressure in the steam cylinder just equals the resistance in the air cylinder, and beyond that point to the end of the stroke the steam pressure must be assisted by the momentum of the fly wheels. The inadequacy of the steam to maintain the running really begins before the point is reached where the lines cross, because there is the entire friction of the machine to be overcome and the running speed to be maintained, so that we may see that the actual reversal of the balance of the driving forces occurs very near midstroke, no matter in which direction the crank shaft turns.

The story of what happens is told graphically in Fig. 2 and Fig. 3 and it would seem that little explanation should be required. In Fig. 2 the shaft runs over and in Fig. 3 it runs under. At the crosshead+indicates that it is pressing the slide while—shows the reverse. The vertical arrows at each side of the midstroke line show the vertical thrust of the crosshead for that portion of the stroke.

It will be seen that there is but one reversal, and back again, of the connecting rod stress for the revolution. Running in either direction there is a thrust for about one half of the revolution and a pull for the other half. The crosshead, however, shows four consecutive reversals of vertical thrust for each revolution. If there is any conclusive reason why the crank shaft should turn in one direction in preference to the other the writer has failed to discover it.—*Power.*

Leakage in subaqueous tunnels in gallons per 24 hours per lineal foot of single bore, was recently stated by Mr. W. J. Wilgus to be as follows: North River tunnels of the Pennsylvania Railroad, 0.15; Detroit River, 0.85; East Boston, 1.35; East River tunnels of Pennsylvania Railroad, 1.00 to 2.00; North River tunnels of Hudson & Manhattan Railroad, 2.28 Battery tunnel of New York subway, 1.68; Sarnia, 2.46.

TESTS OF TURBO COMPRESSORS

Tests of rotary air compressors of the Rateau or turbine type, built by Pokorny & Wittekind Maschinenbau A.-G., of Frankfort-Bockenheim, Germany, were noted in London *Engineering* of Dec. 15, 1911. The first of these was built in 1909 for the Reden mines near Saarbrücken. It is driven at 4200 r.p.m. by a 1000-hp. mixed-pressure steam turbine. The tests were conducted by Prof. Lander, of the Aachen Technical High School. With 264,900 cu. ft. of free air compressed per hour from one to seven atmospheres (99.6 lb. absolute), the consumption of exhaust steam (taken at 15.6 lb. absolute and discharged at 1.14 lb.) was 7.98 lb. per 100 cu. ft. of free air and with this also was used 5.05 lb. of live steam (at 85 lb. absolute).

The second compressor was built for the Könnigsborn A.-G. für Bergbau, Salinen und Sodabetrieb, at Unna-Königsborn, Westphalia. It is driven by a 1000- hp. mixed-pressure turbine and has six wheels in the low-pressure group with seven in the high. There is an intercooler between stages, and between each impeller wheel is a water-cooled partition. Air is discharged at 60 to 70° C. Prof. Lander's tests showed that with 287,000 cu. ft. of air compressed per hour from atmospheric pressure up to about 114,000 lb. per sq. in. absolute, 7.74 lb. of exhaust steam (taken at 17.7 lb. absolute and discharged at 1.47 lb.) was required per 100 lb. of free air together with 4.54 lb. of live steam (at 103 lb. absolute). The isothermal efficiency of the compressor was from 64 to 65 per cent. Tests were also made on one of six 4000-hp. motor-driven compressors of this type, built for the Rand mines in Johannesburg, South Africa. It had a capacity of 1,250,000 cu. ft. of free air per minute (from 11.8 lb. absolute to 128 lb., air being taken at about 20° C.). The compressor is in two sections, each shaft being driven by a 2000-hp. 3000-r.p.m. synchronous motor. The shafts are parallel and there are two low-pressure compressor sections on each shaft. One shaft also carries the intermediate stage and the other the high-pressure stage. When compressing 1,425,000 cu. ft. of free air per minute to 115 lb. absolute, the energy consumption per 100 cu. ft. of free air was 0.301 hp. The highest "isothermal efficiency" secured was 67.7 per cent.

DIFFERENT UNITS OF MEASUREMENT

Scientists use a unit of space depending upon the magnitudes of the things with which they are dealing. If they are interested in very small things, they use the cubic centimeter or cubic inch. If they are engineers, engaged in making excavations such as the Panama Canal, they use the cubic yard. If they are geologists, considering the volume of the continents and oceans and how the continents are washed into the oceans, they use the cubic mile.

The largest unit in use by scientists is that which astronomers employ when they measure the celestial spaces. Their unit of volume is a sphere whose radius is 200,000 times 100,000,000 miles. The volume of this unit is approximately the radius cubed and multiplied by 4. The number of cubic miles in this unit is therefore represented approximately by 3 followed by 40 ciphers.

Obviously, the reason astronomers use such an enormous unit of space is that the volumes with which they deal are very great. But one might ask if this unit is not much larger than is necessary. Indeed, it is scarcely thinkable that it would not include the whole universe. If such a sphere were constructed with its center at the sun and its surface out in every direction to the distance of 200,000 times 100,000,000 miles, one might ask if it would not contain within its limits the North Star, the Pleiades, the Milky Way, and all the other stars that fill the sky. The astonishing answer to this question is, however, that there would not be another star in it besides the sun. Most of them are hundreds of times as far away from us as the surface of this immense sphere would be. The appalling magnitude of the universe is indicated by the fact that there is, on the average, but one star in seven or eight of these enormous units of space, though through the great modern telescopes the stars seem literally to fill the sky.

The tunnel continuing the Jungfrau railway from the Eismeer station to the Jungfrau Jock "saddle," which is 11,400 ft. above sea level, was recently "holed through." The tunnel emerges only about 2000 ft below the summit of the mountain and it is expected that the railway to the top will be completed in about three years.

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EVERYTHING PNEUMATIC

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BUSINESS LONGSIGHTEDNESS

The rock drill from the beginning of its modern and successful career in mining and tunneling work, has been almost entirely the creature of the air compressor. The builders of the one quite naturally became the builders of the other also, and the business in both lines has grown, with one firm at least, to enormous proportions, and with every assurance of not only permanent but also of continually increasing activity. Quite naturally there should be great unwillingness to interfere with the strong, deep flow of such an established business.

The air driven rock drill has had no successful rival in its special field up to the present time, and it might be expected that if one should appear every known defensive device would be arrayed to resist the attack, and aggressive measures for its annihilation might be looked for. Electricity with its omnivorous and pushing instincts has continually sought its share in the rock cutting work, but with little promise of success by any direct attack. All that has been required to be done defensively by the air driven rock drill and the air compressor interests thus far has been to leave it alone.

But the electric air drill, which now comes upon the stage, is an entirely different proposition from any which have preceded it. This is a mechanical compromise with no surrender on either side. The drill piston in the electric air drill is actuated by air pressure as completely as any drill piston ever was, but the motive power behind the air is electric and the big air compressor is ignored and forgotten.

Talking now only of the apparent possibilities of the case, the coming of the electric air drill must have meant something ominous to the established workers in the older lines. It apparently threatened a revolution in methods of working and a superseding of the old line of machinery, with all which this might mean to the manufacturers who had hitherto supplied the market. In the presence of the new drill the old central compressor plant is useless, and how must it strike the compressor builder?

Valuable and revolutionary inventions have before this been killed, or held back for years, in the interest of established businesses, and we might well believe that in this case the temptation may have appealed with force. The patents are secure and ample to cover completely all the essential features of the new system, so that, as new inventions go, and as the inventors of disturbing things are apt to know, it would have been a simple and an easy matter to have first obtained control and then to have put the whole thing, not where it would have done the most good to those it was fitted to work for, but where it would have done the least harm—or none at all—to firmly established manufacturers.

Nevertheless, in this case, the builders of the old are the builders of the new, and they are apparently going into this branch of the business and pushing it, as is their wont, "for all it is worth."

There are of course different ways of looking at this. There are those, we know, who would regard it as an exhibition of business folly or short-sightedness, who would have thought it much the wiser to have held securely the business already in hand, the current apparatus already doing well enough for all concerned, and there being no question as to the continuance of reasonable profits.

The other view is, after all, undoubtedly the correct one. A manufacturer, or any business man, must in the long run be true to the permanent customer. When a firm has gone along for years continually making its product more efficient, reliable, desirable, the only thing for it is to keep on doing so; and though the possible changes as they come along may seem quite revolutionary, if they bring the same promise of increased efficiency that fact should determine their adoption.

After all, the result may be that the new drill will not to any great extent drive out the old, but will make a new field of employment for itself, and in that way lead as usual to a considerable enlargement of the already enormous business which is behind it.

AIR PISTON LEAKAGE

Editor Compressed Air Magazine.

For the benefit of engineers, mechanics and readers of your valuable paper who might gain a wrong impression, and with all due respect to Mr. E. A. Rix, I wish to take exception to a statement in that gentleman's article in the March issue, entitled "Operation of Air Compressors."

Under the sub-heading "Piston and Piston-rod leakage," it is stated that no piston is ever tight in an air compressor even when it is new and fitted with the best of rings. The author seeks to prove this by applying pressure on one side of the piston and observing the flow from the other side.

In the first place, two surfaces, properly lubricated and passing over each other at considerable speed will be perfectly tight, while they might permit considerable leakage at low speeds or when standing still, so a standing test is no indication of the working tightness of piston rings. This is well shown in fully balanced steam valves, particularly of the solid slide type, which require a long travel and a high engine speed, under which conditions they will be dead tight but decidedly leaky at slow speed. Time is an important element in the matter and it should be considered that in a single stage machine at 100 pounds and 150 r. p. m. the high pressure exists against the piston rings but 1-15th of a second, roughly speaking.

Another illustration of the importance of surface speed is the perfect tightness of the construction used on Prof. Sweet's Straight-Line engine—simply a long sleeve of excellent workmanship through which the rod passes without packing of any kind.

I would also say that it is entirely practical to make piston rings which will be tight when standing—a proof of which is seen particularly in many high-grade automobile engines which will hold high compression for several hours standing. Both the cylinders and rings are, of course, ground.

While it is not usual to grind the cylinders of air compressors, the rings should be ground, and if properly designed and manipulated in the shop a perfectly tight operating fit will result.

The writer has designed compressors with single acting high pressure cylinder for 400 to 600 pounds pressure which operated with no leakage which could be detected.

Erie, Pa. H. EDSIL BARR.

The Draeger helmet used on the U. S. Mine Rescue car No. 1, was recently given a severe under-water test in the swimming pool of the Y. M. C. A. at Pittston, Pa. On the first trial the demonstrator remained down eight minutes; on the second 12½ minutes, and on the third 21 minutes and 40 seconds. The last figure exceeds considerably the unofficial record for such a test of 17 minutes, as listed in the records of the department.

CONTRACTOR EXPERIENCE

The most I ever learned about handling sewer jobs was from old Tom Maloney, and he couldn't read or write. He was a man that could do as much work with a shovel as two ordinary men, and I used him to pace the crew on one job. One day I went to him and I says: "Tom, you are a man I think will make a good boss. Tomorrow I am going to put you up on Seventh street in charge of the gang." That old son of a gun says: "If it is at all the same to you, Mr. Connor, I don't want the job. If you want to take me away to some other place where I am a stranger, I will take any job you want to give me. Right here everyone knows me and the gang would all quit the minnit I says to them I am the foreman. I will go up on that job if you like to put it out on station work, though. I will take it that way." I wasn't ready for station work on that job, for there were things coming up that I wanted to save for the men to hold them, so I told him that I would wait awhile and he could keep on where he was. Then the next day he said to me that if I thought he was a good enough man to be a foreman, and as he was doing the work of two men now, he thought he ought to get two men's pay. That is what I got for swelling the head of an ignorant man. Of course, I never gave him the raise, and at the next meeting of the council Tom walks in and takes away a contract that I thought was mine and had kept everyone else away from. Then he hires away my best men to work for him on it.

It was only a small job, but it looked like it would break me up on my time limit, and besides it left me only scrubs, for Tom put every man to work that wanted to work and put them all on station work, too. So I goes around and talks with him and finds he stands better in the town than I thought he did and he owned a lot of property, too. You see, he went there when there was no town and just stayed and saw it grow up around his farm. He had the work habit, and because he had to work he took pick and shovel jobs, and his wife and kids had got used to it, for he was mighty stubborn. So I fixes up a deal with him and soon the firm of Connor & Maloney was doing all the sewer work in that town. We did it for three years, too, when the old man died. During all the time he was managing the work for me one of his kids kept the books and I only showed up in town twice a year. You see, the old man had only hiredman's blood in him, after all, and thought all the time that I was the boss, when, as a matter of fact, he was the sole contractor and all I did was to go around and eat melons when he cut them. There was that fine old chap who could not read and write and with a mighty big brain and lots of hard-headed horse sense who might have been a big contractor if he had the guts. He was a good one, but had to have some one over him to rely upon.—*The Contractor.*

RESUSCITATING THE ASPHYXIATED

The pulmotor is an apparatus for forcing air or oxygen into the lungs of an unconscious patient to compel inspiration and consequent aeration of the blood. This seems to be simple, and is. In fact, the Commonwealth Edison Co., of Chicago, utilized a vacuum cleaner mechanism to produce the pressure, connecting the vacuum side with the air supply and the exhaust side by a tube with a mouth and nostril mask applied to the face of the asphyxiated patient. A device is also provided to keep the tongue out of the way. Between the mask and the air pump is a valve operated electrically by timing clockwork so that the operation of filling the lungs and permitting the air to escape is repeated automatically every three or four seconds. This is known as the Richter system and is packed in a box the size of a suit case. All it needs is to be connected to the electric light circuit and the patient.

A similar device has been adopted by Mr. Gross, of the Washington gas company, following the same idea of German origin. This pulmotor consists of a flask of compressed oxygen which is used instead of air and is quicker in its action. The operation is the same as with the Richter apparatus, except that two bellows were used to force gas into and take it away from the lungs. Dr. J. A. Holmes, of the United States Bureau of Mines, has used this apparatus with great success in cases of accidents in mines.

The purpose is to forcibly continue respiration after the muscles lack the strength to do so, and the idea is as logical as the results are successful. The method is not confined to gaseous asphyxiation, but is useful in drowning cases or in reviving those rendered unconscious by electric shock. No manual labor or artificial rib motion is necessary; the pressure of the oxygen fills the lungs and when the pressure is released the natural elasticity of the lungs expels the used gas. Thus an emergency device could be simply a small oxygen flask, the valve of which is operated by hand, a nose and mouth mask and device to keep the throat open.

There have been a number of remarkable rescues made by this method recently. On Feb. 15 four Chicago victims were revived. One case required 4½ hours before there was any sign of life, and after two more hours of this forced breathing the man took up his bed and walked. Cases generally require from one to three hours' treatment. This was the 44th case revived by the Edison company in Chicago, the victims of gas asphyxiation in five cases having ceased breathing altogether. Most of these cases were traced to imperfect gas fixtures, although 10 were attempts at suicide found almost dead. The company places this rescue work at the people's disposal, advertises it and gets much favorable publicity thereby. Here is an opportunity for gas companies to make friends with the people and protect them, as well as their own employes, from untimely dissolution.—*Progressive Age.*

ANKYLOSTOMIASIS AT LINARES, SPAIN

There are about 200 lead mines in the district of Linares, Spain, but owing to the depressed condition of the lead industry, only about 35 of these are at work, and in 20 of them ankylostomiasis is prevalent, says *Revista Minera.* The number of persons employed underground is about 2500 to 3000 and of these it is estimated that about 10 per cent. are affected. Conditions are favorable for the propagation of the parasite, as the lodes worked are in wet granite, and most of the work is being done at a depth of about 1500 ft., the temperature varying between 80 and 86° F. All the usual symptoms of the disease are noted among the miners, and newcomers to the mines have been found to succumb to the disease within 12 months. It is stated that up to the present no sanitary precautions have been taken either to alleviate the infection or to provide against it, but *Echo des Mines,* Feb. 15, 1912, says that the Spanish government is about to take up the matter.

SOLID AND PNEUMATIC TIRES

No single pneumatic tire, even of the largest diameter, can be expected to carry a load of more than 1,350 pounds. Experiments have been made to discover the relation existing between the lasting power of a tire and the weight it supports, and from the results of a great number of tests has been deduced the following empiric laws: "The mileage of a tire is inversely proportionate to the cube of the weight it supports."

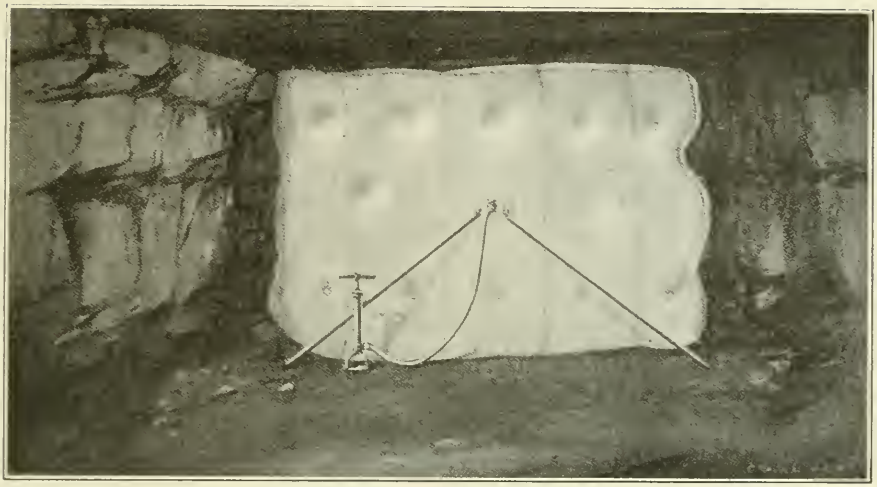
Thus if the weight is doubled, the wear will be approximately eight times more rapid. If the weight be increased by even so little as 5 per cent, the wear on the tire will be increased about 14 per cent. Thus, as soon as the weight is increased, it is discovered that the tires wear out with extreme rapidity. Accordingly it has been impossible up to the present to make use of this wonderful spring of compressed air. The solid rubber tire has been retained simply to lessen the noise and reduce the violence of the jolting.

INCOMPRESSIBILITY OF RUBBER.

Rubber, unfortunately, although elastic to a remarkable degree and extremely pliable, is nevertheless almost incompressible, much more so, indeed, than the greater number of solid bodies—a strange fact, which is but little known.

Consequently, tires made of solid rubber give practically the same result as if hollow and filled with water. With such a tire, a jolt would cause but a very small alteration in its shape, on account of the slight displacement of the molecules of water, which move slowly among themselves.

But in an air-filled tire a similar jolt would cause a great change in shape because of the instantaneous displacement of a complete layer of the compressed air, the molecules in this case being extremely rapid in their movement.



STOPPING AIR FROM A MINE FIRE.

AIR MATTRESSES FOR CONFINING MINE FIRES

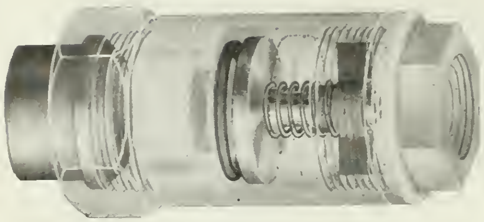
In the current issues of *Coal Age* a discussion has been in progress as to the best methods of dealing with mine fires. From letter No. 24, by Carl Scholz, Vice President and General Manager, Consolidated Indian Coal Co., is as follows:

I think that when a fire occurs at the end of an entry, the first thing to do is to diminish the circulation of the air past the fire. Under ordinary conditions, it would seem easier to build a wall on the intake side first; then, by reversing the circulation, the smoke could be forced back so that the fire would be confined to the smallest possible area. This would reduce the supply of air, walled in with the fire, to a minimum. To accomplish this, it is best to set the first stopping of brattice cloth or lumber far enough ahead of the last open cross-cut to permit of the building of a permanent wall between the crosscut and the temporary brattice.

In some gassy mines, square air mattresses, blown up by a hand air pump, as in the illustration, are utilized to make the first stopping. With these provided, in about four minutes the circulation can be stopped and the sealed-off territory reduced to a much smaller limit than could be done if the men had to build more elaborate stoppings in the smoke.

I inclose a rough sketch of such a pneumatic curtain. It can be folded up and quickly carried to the place affected. The mattress is 14 in. thick, and in its other dimensions is the size of the heading it is intended to fill. A central plate, with a pipe affixed thereto, permits the attachment of a rubber hose, through which the air can be pumped into the mattress for purposes of inflation. The bag stopping is supported temporarily by four legs, two of which are hinged to the central plate just mentioned, and two to a corresponding plate at the rear. The front and back walls of the mattresses are prevented from bulging outward under the air pressure by the use of ribbon stays. When the bag is properly inflated, it fits and adheres to all the various irregularities of the outline of the heading, and is prevented from forming itself into the shape of a balloon by the restraining force of the stays, just mentioned.

Some large turbo-compressors are now in successful operation in Germany. One of these installed at the Reden mine, near Saarbrucken, runs at 4,200 r. p. m. and compresses over 4,000 cu. ft. of free air per min. to 90 lbs. gage. Another, installed in Westphalia, runs at the same speed with a capacity of 6,000 cu. ft. of free air per min. delivered at a pressure of 105 lbs. gage. The efficiency of the compressor, compared with isothermal varies between 64 and 65 per cent. The steam turbine works with exhaust steam at efficiency of about 68 per cent. and with boiler steam at 66 per cent.



THE PEERLESS AIR CHECK VALVE

The check valve here shown in a "phantom" halftone is found very satisfactory in trolley car service, and it would seem to be deserving of wider employment. It is simple and effective and requires no explanation as to its working. It is used in a vertical position, instead of the horizontal as here shown, and is placed in the air delivery pipe between the compressor and the reservoir, preferably as near to the latter as possible. In trolley car brake service the electric driven compressor, automatically controlled, works intermittently with usually considerable intervals of rest. It is an open secret that compressors are not absolutely air tight, and when not at work, if the delivery pressure is constantly upon them, more or less air is lost while the compressor must start up against the pressure, whatever it may be. With the check valve in the pipe the loss of air is avoided, except the little remaining in the pipe itself, and the leakage here and back through the valves and piston enables the compressor to start with little or no load, a very important feature in connection with the electric drive.

NOTES

A Montreal syndicate, it is reported, has prepared plans for a million-horse-power hydro-electric development near Montreal. It is proposed to divert the whole course of the St. Lawrence River at Coteau and Cedar Rapids. The cost of the dam will be $25,000,000, and the syndicate's capitalization is said to be $100,000,000. To pay dividends on this sum will require the development of nearly one-half million horse-power.

The oldest road in America, in all probability, will shortly be macadamized by the Isthmian Canal Commission. It runs from the ruins of the old city of Panama to Cruces, on the Chagres River, where it was customary in the old days to take boats to Fort Lorenzo or to take a trail constructed somewhat later to Porto Bello. The road was in use before 1537 and was paved with cobble stones and flat rocks. There will be about 18 miles of this famous treasure route macadamized.

One individual commented on the fact that there must be plenty of coal near to New York because while coming into town the other day he saw many car loads of it standing on track. "Why," said he, "there must be a mile of coal-laden cars out there on the meadows." Well, granted that there was a mile of coal-laden cars and taking the cars as containing 50 tons each on an average, how many tons does that figure out? Just about 6,000; enough for one trip of the Lusitania.

Two doctors in Chicago have recently devised an electrically-operated mechanism for producing artificial respiration during operations of lung surgery. Air is introduced into the lungs by a compressor through a valve operated by an electro-magnet. The valve is opened and closed periodically under control of a clock mechanism. This apparatus is reported to have sustained life in a dying patient for twenty-nine hours, while the surgeons were endeavoring to restore the lungs to the performance of their natural functions.

A very large pneumatic caisson was recently sunk in the foundations of the Telephone Building in New York. It is 35 ft. 4¼ in. x 38 ft. 2 in. in plan and is built entirely of reinforced concrete. This is said to be the largest pneumatic caisson for the foundations of a building on record. Ten building columns will be carried upon it. The contractors, the O'Rourke Engineering Construction Company, of New York, completed the work of sinking it 40 ft. below the level of the curb in 3½ days.

An automatic air door is described in *Bergbau*. The door opens automatically when a car or train of cars rolls upon the inclined rails. The car pulls the lever down by its weight and the axis with bevel gear wheel, which is attached above the door, makes a slight turn. This movement communicates itself to the door hinges and the door opens. The upright bars and the counter-weight close the door again. The weight can be regulated so that the door will open when workmen step on the inclined rails. The great advantage in this automatic door is the fact that it does not come in contact with the cars or locomotives of trains and is safe against all chance of damage through a collision.

Admitting compressed air into the gas-engine cylinder at the end of the exhaust stroke is proposed in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure*. It is recognized that the residual burned gases remaining in the cylinder and mixed with the new charge dilutes the fresh mixture, impoverishes it, and generally interferes with the ignition of the charge, unduly elevates the initial temperature, predisposes the motor to premature explosion, and affects the efficiency of operation. It was there shown by means of diagrams and figures of a number of tests how the efficiency was increased as the result of the adoption of the valve which admits the air under pressure at the end of the exhaust stroke.

In explosives for use in the open air, such as, for example, quarrying or railroad excavation, strength and efficiency in removing rock are the qualities that are most important, and usually are the only ones that need consideration. Explosives that are to be used in tunneling must not only possess strength and efficiency, but also be of such composition that upon exploding they will not give off large quantities of poisonous or offensive gases. In explosives intended for use in coal mines, a further property is most important. Besides possessing the qualities of strength, efficiency in breaking down coal, and freedom from poisonous explosion products, the explosive should be of such nature as not readily to ignite explosive mixtures of gas or coal dust.

The Swiss seem to take naturally to tunnels. On the chief line from the North, passing southeast from Basel to Olten, the railway goes under one of the Jura ranges by the Hanentein tunnel, which has the respectable length of 8,187 ft. Not satisfied with that, the Swiss have let a contract to straighten 10 miles of the line, by which they will shorten the distance 369 ft., but at the cost of an entirely new tunnel no less than five miles long (26,698 ft.). Of course it is not for the sake of the saving in distance that this great work is undertaken. The old tunnel rises with a grade of 139 ft. per mile, and it has become almost impossible on account of the steep grade to get the traffic through this tunnel. The steepest grade on the new line is to be only 56 ft. per mile, and its summit will be 361 ft. lower than the summit of the existing line.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 6.

1,016,263. VACUUM-CLEANER. John H. Green, Springfield, Ill.

1,016,264. SENDING AND DELIVERY STATION FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Karl Anton Gutknecht, Hamburg, Germany.

1,016,384-5. RAILWAY-SIGNAL. Walter P. Allen, Ardmore, Pa.

1,016,411. TRACK-CLEANER. Louis Isaacs, Louisville, Ky.

1,016,415. SAND-BLAST DEVICE. Albert Jorn, Jr., Waukegan, Ill.

1. In a sand blast machine, a nozzle, a table at one side of the upper portion of the nozzle, said table having an inclined portion, means for piling sand upon the table and adjacent said inclined portion, and means for directing an air blast into the nozzle.

1,016,418. PNEUMATIC SUSPENSION FOR VEHICLES. William Kneen, London, England.

1,016,487. ETCHING APPARATUS. James S. Freer, Rutherford, N. J.

1. An etching apparatus comprising a tank adapted to contain an etching bath, an air distributing pipe arranged at the bottom thereof and having a plurality of air egress openings, a pair of alined bearings in the tank above said pipe, a rock shaft hung in said bearings, means for clamping a work plate to said shaft, manually operable means for turning the shaft and thereby swinging the work plate into a horizontal position beneath the level of the bath, and a stop for checking the descent of said plate.

1,016,558. PNEUMATIC ATTACHMENT FOR VEHICLE-WHEELS. Herman Garrison, Chicago, Ill.

1. An attachment of the character described consisting of a pneumatic tire of the ordinary construction fitted to the rim of the wheel, and an expansible pneumatic mounted on the wheel in communication with said tire and between the hub and rim of the wheel, said pneumatic comprising a pair of spaced apart plates, a flexible construction extending between the respective edges of said plates, and means to press one of said plates toward the other.

1,016,577. BLOWING-ENGINE. Johann F. M. Patitz, Milwaukee, Wis.

1,016,600. VACUUM-CLEANER. Eugene W. Applegate, Hoboken, N. J.

1,016,603. COMBINED INTERNAL-COMBUSTION ENGINE AND COMPRESSED-AIR ENGINE. Charles Whiting Baker, Montclair, N. J.

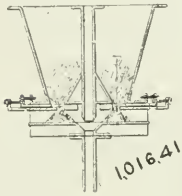
1. The combination of an internal-combustion engine having air-compressing cylinders arranged tandem with the engine cylinders but absorbing a part only of its power, a reservoir to which the air from the compressing cylinders is directly piped, a reciprocating compressed air engine drawing its supply from the reservoir and driving the same shaft as the internal-combustion engine, and a heater separated from the engine in which the exhaust gas from the internal-combustion engine imparts heat to the compressed air in its passage from the reservoir to the air engine.

1,016,651. PNEUMATIC SPRING. William H. Staats, Colonie, N. Y.

1,016,656. PROCESS OF CURING MEAT. Charles B. Trescott, Indianapolis, Ind.

3. The process of curing meat for the purpose set forth, which consists in confining it against the access of air, pumping out the air in and about the meat supplanting said air with carbonic acid gas, and subjecting the meat so treated to the action of salt.

1,016,658. CONTROLLER FOR PNEUMATIC MOTORS. Eugene T. Turney, Rock Island, Ill.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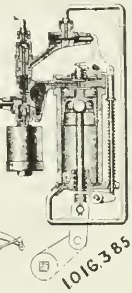
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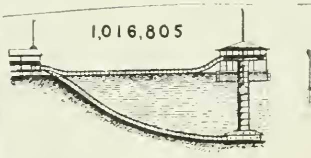
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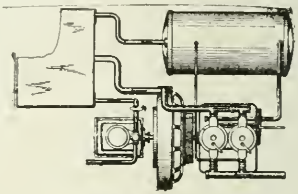
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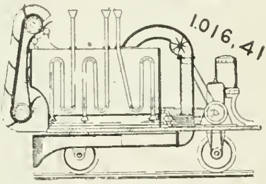
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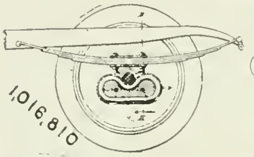
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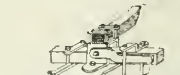
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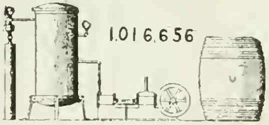
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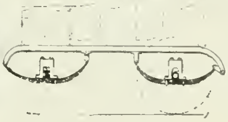
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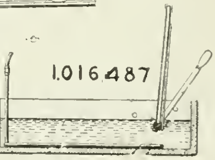
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1,016,808. SUBMARINE PLEASURE APPARATUS. Charles Williamson, Norfolk, Va.

1. A submarine pleasure apparatus comprising a submergible chamber having observation windows in its walls some at an angle to the vertical and others adjacent to them in vertical planes.

1,016,810. PNEUMATIC SUSPENSION DEVICE FOR VEHICLES. John Williamson, Brooklyn, N. Y.

1,016,830. PORTABLE AIR-WITHDRAWING OR VACUUM-PRODUCING APPARATUS. Alexander Mackenzie Jack, Sheffield, England.

1,016,896. SYSTEM FOR INFLATING PNEUMATIC TIRES. Charles A. Rivers, Denver, Colo.

1,016,917. PNEUMATIC PLAYER MECHANISM. Francis W. Draper, Richmond, Ind.

FEBRUARY 13.

1,016,934. FLUID-METER. Thomas Charlton, Chicago, Ill.

1,016,938. SIPHON-SKIMMER. Chester A. Gilkerson, Joliet, Ill.

1,017,001. TURBINE-BLOWER. Patrick H. Kane, Buffalo, N. Y.

1,017,011. AIR-BRAKE. William E. Mead, Marshall, Tex.

1,017,086. PROCESS OF REMOVING ALCOHOL FROM AND PURIFYING BEER. Henry E. Deckebach, Cincinnati, Ohio.

The process of treating beer consisting of withdrawing it from the fermenting tub, passing heated, compressed air through it, carrying off the air, sending the beer through a cooler, thence carrying it through a strainer, returning it from the strainer to the fermenting tub, and continuing the circulation until the beer has been lowered to the desired temperature.

1,017,216. FLUID-CLUTCH. Gustave T. Johnson, Chicago, Ill.

1,017,240. AERATION OF LIQUIDS. Arthur James Billows, Melbourne, Victoria, Australia.

1,017,258. OZONIZING APPARATUS. Max Fuss, Berlin, Germany.

1,017,275. SUCTION-CLEANER. John George Walker, Sewaren, N. J.

1,017,358. AIR-BRUSH. Olaus C. Wold, Chicago, Ill.

1,017,361. AERATION OF DOUGH. Matthew A. Adam, London, England.

1. A process of dough treatment consisting in subdividing the dough exposing it to a suitable free oxygen containing gas under pressure and recombining the dough while still under gaseous pressure; as set forth.

1,017,388. PNEUMATIC RUBBING-MACHINE. Jeremiah J. Dickson, Indianapolis, Ind.

1,017,405. PULSATOR FOR MILKING-MACHINES. Regner Henry Julius Gjetting, Copenhagen, Denmark.

1,017,442. AUTOMATIC AIR-BRAKE COUPLING. Robert J. Mitchell, Marion, Ohio.

1,017,486. SUBMARINE MINING APPARATUS. Charles Williamson, Norfolk, Va.

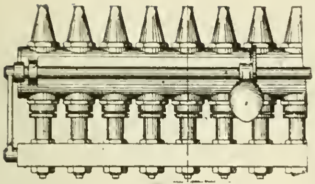
1, A submarine mining apparatus comprising an operating chamber at atmospheric pressure, a work chamber at high pressure associated therewith, means for operating in the work chamber from the operating chamber, a movable receptacle for receiving the products mined, and means for moving said receptacle into and out of said work chamber.

1,017,533. ATOMIZING-NOZZLE. Joseph E. J. Goodlett, Memphis, Tenn.

1. In an atomizing nozzle, a liquid supply head provided with atomizing nozzles, an air supply head, and air conduits movable within said atomizing nozzles and provided with valve heads adapted to open and close the latter.

1,017,538. ENGINE STARTING APPARATUS. Edward A. Halbleib, Rochester, N. Y.

1. An automatic selector for engine-starting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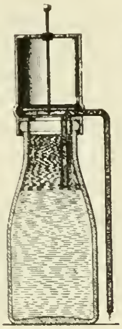
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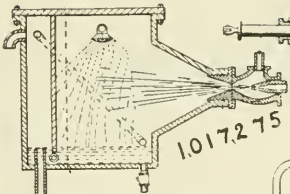
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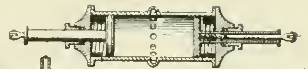
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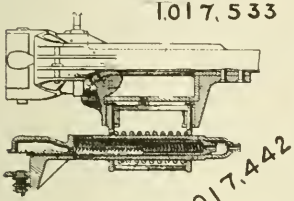
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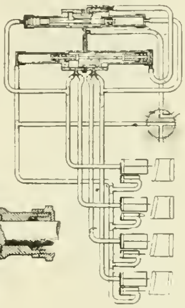
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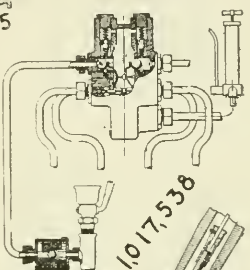
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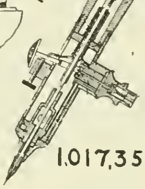
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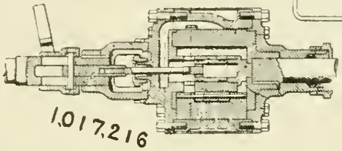
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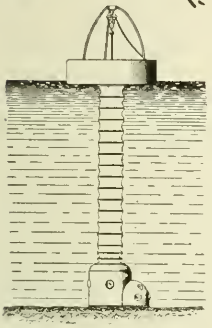
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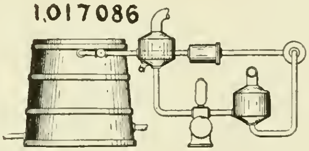
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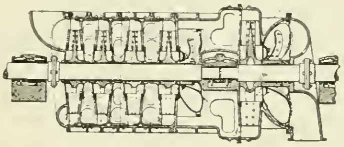
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apparatus having, in combination, valves for controlling the admission of air to the respective cylinders of an engine, said valves being movable into open position by pressure from the respective cylinders, and connections between the valves whereby movement of either valve to open position causes the movement of a plurality of the other valves to closed position.

1,017,562. PNEUMATIC HAMMER. ERNST HJALMAR LAGERSTROM, Stockholm, Sweden.

FEBRUARY 20.

1,017,648. VACUUM LIGHTNING-ARRESTER. FRANK SPENCER CHAPMAN and JOHN TYLER GREENE, Toledo, Ohio.

1. A vacuum lightning arrester, comprising a chamber, a central perforated insulating barrier located in said chamber, and a pair of conducting plates having inwardly extending projections directed toward said perforated plate.

1,017,685. JOLT-RAMMING APPARATUS. EDGAR H. MUMFORD, Philadelphia, Pa.

1,017,704. TESTING APPARATUS FOR HOLLOW CASTINGS. GEORGE C. TALLMAN, Syracuse, N. Y.

1,017,707. CASTING APPARATUS. FRANK W. TRACY, Chicago, Ill.

1. A casting apparatus comprising a closed crucible, a flask below said crucible the sprue of which is in register with the gate of said crucible, means for supplying molten metal to said closed crucible consisting of a measuring chamber and alternating operative valves controlling the feed and discharge of said chamber, and devices for supplying air under pressure to said crucible and forcing the molten metal into said flask.

1,017,722. GAS-PUMP FOR OIL-WELLS. JAMES PHILLIP WINTZ, Ripley, W. Va.

1,017,746. PNEUMATIC GUN FOR THROWING LIFE-LINES. INGEBRIGT J. GLERUM, Devils Lake, N. D.

1,017,779. PNEUMATIC CARPET-SWEEPER. THOMAS LYONS, Cleveland, Ohio.

1,017,787. AIR-BRAKE APPARATUS. BLYTHE J. MINNIER, Watertown, N. Y.

1,017,835. APPARATUS FOR COMPRESSING AND DISTRIBUTING AIR UNDER PRESSURE. MELVILLE C. WILKINSON, Paloverde Valley, Cal.

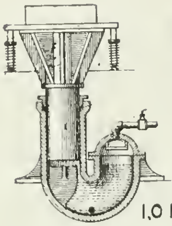
1. An air compressing and distributing mechanism, comprising a compressing means, a system of piping connected with the induction and the eduction sides of said compressor, a movable member interposed between the sides of said system and operable by the relative pressures in the two sides of the system for causing the compressor to take air from either side of the system and thus maintain the pressure in the two sides at a given rate with respect to each other.

1,018,109. RODENT-EXTERMINATOR. DELVIN B. HARRIS, Minturn, Cal.

1. A device of the character described comprising a liquid tank, an air pump, a hose having a nozzle on its end, means connecting said tank and said air pump with said nozzle, points projecting outwardly from said nozzle, batteries disposed at a distance from said nozzle, wires extending from said batteries to said points, and means for completing a circuit through said batteries and to said points for the purpose of forming a spark as described.

1,018,221. COMPRESSOR. JAMES B. VERNON and GEORGE DE CAMP, St. Louis, Mo.

1,018,238. DETACHABLE RIM FOR PNEUMATIC TIRES. PERRY ERNEST DOOLITTLE, Ontario, Canada.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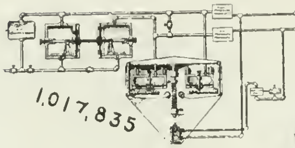
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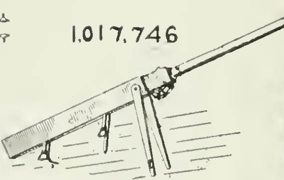
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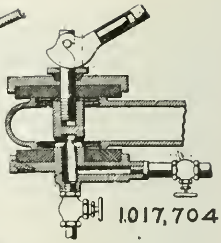
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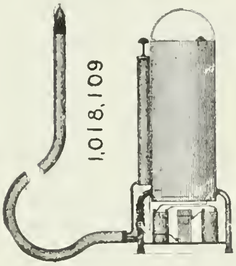
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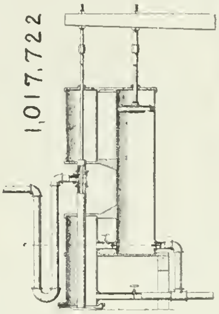
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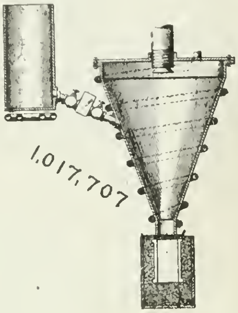
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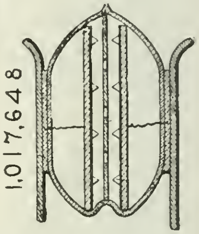

1,017,648

FEBRUARY 27.

1,018,412. FLUID-ACTUATED CLUTCH. RUDOLF DIESEL, Munich, Germany.

1,018,428. PNEUMATIC WHEEL-HUB. FRED J. KOCH, East St. Louis, Ill.

1,018,483. APPARATUS FOR BLOWING PIPE-ORGANS, HARMONIUMS, OR LIKE MUSICAL INSTRUMENTS. LOUIS BERTRAM COUSANS, Lincoln, England.

1,018,561. METER. EMBURY A. HITCHCOCK, Columbus, Ohio.

1,018,568. APPARATUS FOR MAKING SOLID CARBON DIOXID. HARRY P. JULIUS, St. Louis, Mo.

A condensing and compressing apparatus for liquid carbon dioxid, comprising a tube, a head detachably mounted in one end of said tube having means for connection to the outlet of a liquid carbon dioxid storage tank, a second head detachably mounted in the other end of said tube having a threaded opening therethrough, a threaded bushing mounted in said threaded opening, a stem non-rotatably mounted in said bushing and adapted for reciprocation longitudinally of the tube, and a reciprocating plunger mounted in said tube and secured to said stem.

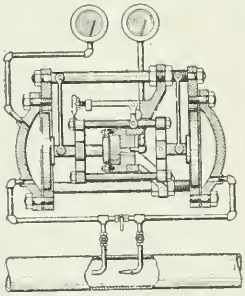
1,018,582. PRESSURE-GAGE. THOMAS A. NELSON, Chicago, Ill.

1,018,610. MILKING-MACHINE. REGNER HENRY JULIUS GJETTING, Copenhagen, Denmark.

2. A milking machine comprising in combination, a flap, a second flap movable with respect thereto, means mounting said second mentioned flap permitting oscillation and reciprocation thereof, a cylinder adapted to confine fluid pressure, a piston within said cylinder, means operatively connecting said piston and second mentioned flap to normally draw the same away from said first mentioned flap responsive to fluid expansion within said cylinder, and mechanism for imparting a forward and downward movement to said second mentioned flap, with respect to said first mentioned flap, subject to return movement thereof responsive to action of the fluid pressure within said cylinder.

1,018,772. PNEUMATIC CLUTCH-CONTROLLER. WALTER D. NICKUM and MARTIN CLAUSSEN, Los Angeles, Cal.

1,018,983. PNEUMATIC TOOL. JOHN J. PADBURY, Rockland, Me.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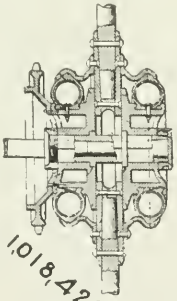
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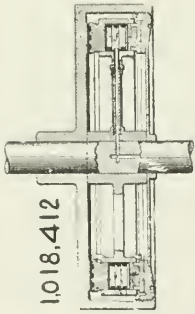
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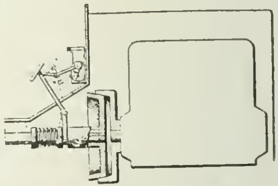
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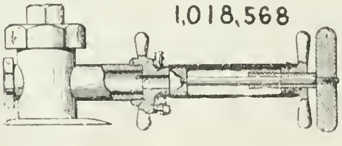
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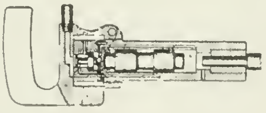
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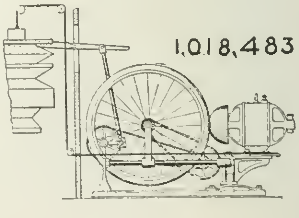
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COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XVII MAY, 1912 No. 5

RAILROADING AROUND THE WORLD

BY W. L. SAUNDERS.

A traveler who encircles the globe learns to appreciate the value of American railways. He also learns to prefer railway traveling, when long distances are concerned, to traveling in ships. One who visits Japan from the United States goes nearly half way around the globe, and if he is in a hurry to get home, appreciates comfort and likes to visit new scenes, he is better off coming home by way of Siberia, Germany, France and the Atlantic Ocean rather than to subject himself to the monotony of the broad Pacific. He also may save a few days, if he makes his connections.

The broad Pacific is interesting only in the contemplation of its expanse. No one can conceive of greater solitude than to be afloat in the Pacific Ocean. Its wave motion is usually moderate, with a broad expanse between the undulating crests. It is smooth on the surface and there are no signs of life, save an occasional flying fish, a rare encounter with porpoises and a whale now and then, whose antics are as welcome to the voyager as sunshine is to the Londoner in a November fog.

Recent railway construction and much improvement in equipment and operation add greatly to the comfort of the Trans-Siberian journey. Until recently one either crossed the Japan Sea, about a three days' journey, or took a more distant route to Port Arthur, and then made his way toward the Russian railways, but now it is simply necessary to travel by the Government railway of Japan to the extreme south of the Islands Shimenoseki, then across the narrowest body of water in that section which separates the Continent from Japan. This is a one night trip only, in comfortable boats, landing one at Fusan, Korea.

A word or two might be said of the railways in Japan. All the principal lines are owned by the Government, and this is always bad. It makes for inefficiency, bad management and lack of the best accommodations. Furthermore the railways in Japan are narrow gage roads, which seem to serve the purpose very well in a small country where the people are personally small in stature, and where furniture and accoutrements, such as we enjoy, are rare. These narrow gage railways are very well equipped for narrow gage railways. The trains go at considerable speeds and except in over night service one is reasonably comfortable.

The road from Fusan northward through the center of Korea is of broad gage with modified Pullman accommodations, under Japanese management, and an improvement on anything experienced in Japana. This road runs continuously through Seoul to Mukden, thence northward on the eastern Chinese Railway to the junction of the Trans-Siberian road at Harbin.

These railroads are patrolled by Japanese soldiers and operated by Japanese workmen. The soldiers do their duty in a manner above criticism, but it is evident that the Japanese are not naturally mechanical and that operating railroads is a service of great difficulty to them. They have in Japan, for instance, copied American and European types of locomotives, and so far as the reproduction is concerned it is perfect, but if anything goes wrong, if a connecting rod should work loose or a hot box trouble occur, the Japanese workman shows little initiative and skill. He is very apt to try the very same experiment he tried when a previous trouble arose, though the causes may be quite different. I have seen six or eight men puzzled for an hour or more over a simple case of hot box, trying all sorts of remedies and showing a lack of clear knowledge of the theory of the trouble. A Japanese mechanic laboriously learns to do a certain thing, and when he masters it he can do that thing well, but if you shift him or introduce a new element in his work he is ill at ease. A simple illustration of this occurred on a Japanese railway where the clasp holding a lady's traveling bag was pulled out. Both the conductor and brakeman puzzled for at least ten minutes in an effort to repair the damage, when the lady herself (a girl of twenty years of age) impatiently took the bag from their hands and fixed it.

The Trans-Siberian Railway runs from Vladivostok to Moscow, a journey of from eight to nine days. The equipment, especially on the International train which runs once a week, is first class, with comfortable cars and good food. In the extreme east coal is burned in the locomotive, but as one reaches the interior of Siberia, where wood is plentiful, the engines are all wood-burning. The gage of this railroad is five feet, which adds to the size and comfort of the cars. The staterooms are large,—some with two beds and others with four. These cars are all of the Russian type, the same as used on the Nord express, which runs from St. Petersburg to Paris, and on the Orient express from Paris to Constantinople. The speed averages a little more than twenty-five miles an hour, generally about thirty, and at times even faster. Stops at stations are not as infrequent as one would suppose, but occur at intervals of two or three hours. The country itself is not a barren waste; there is no desert land in view, but it resembles Canada or a portion of the western United States. There are times that one could imagine the train going through the Coeur d'Alenes in Idaho, or northward through the Cobalt District in Canada. The country is rolling, mountainous only around Lake Baikal and at the Urals; there is much evidence of forests, burned for the purpose of clearing.

There is really less inconvenience, less friction and more real comfort of travel in a trip from Vladivostok to Moscow than from Paris to London. This statement is made deliberately by one who has had experience. Railway traveling becomes tiresome and excites one's nervous system in proportion as the trains wabble around curves, as the cars are crowded and as changes are required while making a journey. The little trip from Paris to London involves all the difficulties of travel. The trains in France and in England are always crowded. There is a rush to look after one's baggage, the cars are light, the tracks laid in curves, the speed high, and one is apt to reach the end only to find it necessary to scramble on to a little bateau with few, if any, comforts, and a passage by water which is either rough or extremely dull. On landing the same experience is repeated.

One learns to appreciate the Pullman car, which through its heavy weight, wide berth and open construction is supreme over anything abroad. While the road beds of Europe are fairly good, little irregularities are more plainly felt through the light equipment used there, hence car sickness is more frequent. The dining car service is satisfactory only in that the food is good. There is little variety about it as it is table d'hote and is served in a perfunctory manner, with a rush and clatter of dishes exceeding anything experienced in an American dinner.

AUTOMATIC STABILITY FOR AEROPLANES

It is stated in a London publication, that an engineer in India who has given close study to the question of aerial flight has made an important discovery regarding the equilibrium of aeroplanes. After many tests he has succeeded, it is stated, in securing an almost automatic stability in flight. A recent test was made in India with the invention fitted to an aeroplane model. The craft was cast into the air from a high point and it immediately floated, being influenced only by a gradual drop toward earth. The aeroplane moved quickly. It maintained its equilibrium throughout. It is claimed that the principle of the invention, if built into an aeroplane, would render perfect the "floating" of an air craft upon an "even keel" and would make toppling over or sudden dropping impossible. Sharp turns can be made also, it is said, and an accident to the motor is rendered of small importance. The details of the invention are a secret. The British War Office will be asked to test the contrivance.

THE AIR LIFT*

BY FRANK RICHARDS.

One of the most important, and now also among the most extensive and most rapidly extending employments of compressed air is in the so called "air lift," used for the raising of water and other liquids. This name is not correctly suggestive of the characteristics of the device, but it seems to be quite firmly fixed and no one seems to be able to supplant it with anything better.

The water-works of many towns and cities in the United States and elsewhere are entirely dependent upon the air lift, and its use for the obtaining of water from its natural subterranean sources is rapidly extending throughout the civilized world. It is used largely for the pumping of oil wells, for the unwatering of mines, and it handles semi-liquids, or liquids carrying a heavy burden of comminuted solid matter, with the same facility as clear water, making the water thus in many cases the cheapest conveyor available.

The adoption of the air lift for any specific service is seldom determined upon by considerations of power economy alone. It has its special adaptations to some exacting conditions, and it may be said to hold its own and to be continually extending its holdings by the fact that it can do work to which no other devices can be applied. The wide range of its employments, and its continuance in them is the best possible evidence that after all it pays. It is also free for anyone to employ it, as there can be no monopoly of the principle involved.

It is not necesary to make any mystery of the operation of the air lift, and no one has any privilege to pose as an exclusive repository of special information concerning it, although in the practical applications of it experience counts for more, and is more absolutely necessary than in almost any other field.

PRINCIPLE OF OPERATION.

The essential principle involved seems to be very simple and to be easy of explanation. Say that we have an open well, or in fact any body of water, so that it be deep enough and regardless of its volume or what may enclose it, a pond or lake or river being as good for our purpose as a well of whatever dimensions; and say that in this water is suspended or fixed a vertical pipe with open ends, the lower end extending a considerable distance below the surface of the water, the water being thus perfectly free to enter the pipe. Under the conditions, the water will rise to the same height inside the pipe as it is outside, and when the water levels coincide there will be nothing operative to cause any movement of the water either upward or downward.

If we wish to induce the water inside the pipe to rise higher than the water outside the pipe it can be done by reducing the weight, or more correctly, the specific gravity of the column of water as a whole contained within the pipe, and then the greater relative weight of the water outside the pipe will act to force the lighter column of water upward. The simplest way in the world to lighten the column of water in the pipe would seem to be to mix air with it, and this the so-called "air lift" does, and it is practically all that it does, while gravity does the rest.

Say that, with our pipe standing in the water as above assumed, and with the water standing at the same height within it as outside, a compressed air pipe considerably smaller than the other is run down alongside with its lower end turned up and reaching a little distance up into the large pipe, as in Fig. 1. In the placing of this air pipe it may be supposed that the water has entered it and has risen in it to the normal water level, if there has been no confined or compressed air in the pipe to oppose it. If now compressed air is turned on to the small pipe with a pressure sufficient to drive the water down to the lowest point in the bend of the pipe, the pressure required being determined by the height of the water surrounding the pipe and this pressure, 1 lb. for each 2 ft. (speaking loosely) of water depth, being the greatest pressure that will be called for in the operating of this particular lift, then as soon as the bend in the pipe is passed the air will escape upwards out of the air pipe and will diffuse itself through the column of water above.

We must not go too fast here. The air "lift" has not yet begun its lifting. The diffusion of the air through the column of water elongates the column of water upward but does not yet lighten it as a whole. The air might go on mixing with and diluting the wa-

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*First printed in *Practical Engineer*, Chicago, April 1, 1912.

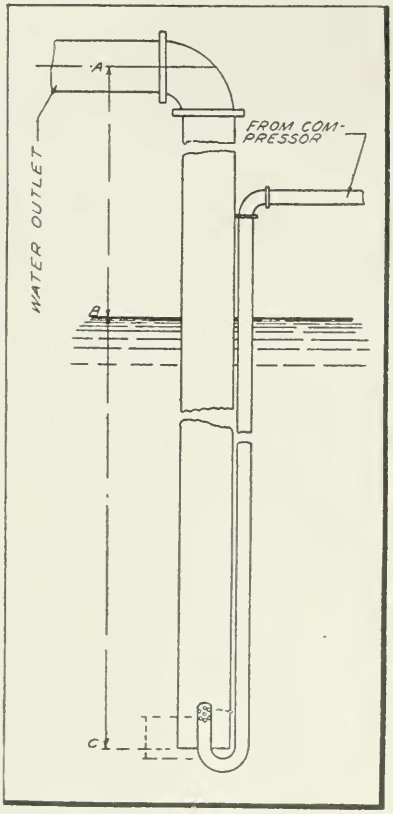


FIG. 1.

ter and gradually working its way up through it and finally, if the pipe was long enough, the the air would escape at the top of the column as fast as it was admitted at the bottom, but still there would be no "lifting" of the water by this operation alone. This gradual working of its way up through the water which the air thus does in the stationary column goes on also, but not so rapidly, when the column is moving and the lift is in full operation, thus constituting the "slippage" which seems to be one of the unavoidable sources of loss in the air lift.

As a matter of fact in the air lift the air does not work its way up through a column of water of unlimited length and escape out of the water at the top, leaving the water inert. Before this height is reached the water pipe ends and there is a continuous discharge of its contents. This discharge of the upper portion of mingled water and air at once reduces the weight of the column and then it begins to be pushed upward by the heavier solid water which is now able to force its way in at the lower end. The escape or discharge at the top makes the column continually lighter than is required to balance and entirely resist the in-pressing water below, so that the solid water continues to flow in, and then the entire column is kept rising and flowing off at the top, as long as the supply of compressed air is sufficient to maintain this condition of unbalanced pressure; and there we have the air lift complete. It is ultimately worked as we see entirely by the force of gravity.

It will be better to finish with the air and its career in the water before considering the action of the resulting unbalanced pressures. The levitation function of the air being understood, it will be evident that it must be desirable to have it mixed as intimately as possible with all the water in the column, so that here ingenuity and invention may play an important part in providing means for scattering the air and mixing it at the beginning all through all the water. If such scattering and intimate mixing of the air with the water does not occur at the instant of its discharge from the air pipe no such result can be possible later. It is to be assumed that the air will be distributed through the water in bubbles, large or small, and it is better that they should be as small and as numerous and as nearly as possible at uniform distances apart rather than to have them fewer and larger and irregularly distributed.

The originally propounded theory of layers of air alternating with pistons of water in the pipe represents an absurd impossibility. Whatever the number and size of the air bubbles at the beginning they will always be merging together to form fewer and larger ones. Whether the aerated column be stationary, as first assumed, or moving upward with the lift in full operation, the levity of the column which the air is employed to produce, will be determined by the amount of air actually distributed through it during the period of its upward passage through the pipe. If some of the air escapes by working up through the column, instead of moving with it, it represents power lost, and this loss will be greater with large bubbles than with small, because they will always float up through the water at the greater speed.

AIR USED ISOTHERMALLY.

In its operation the air lift uses the air expansively and gets the benefit of the expansion. When the lift is in full operation and the air and water mixture is flowing at a uniform speed through the discharge pipe there will be at any instant a given quantity of water and the equivalent of a given volume of free air. The air actually will not be either free air nor air at the full working pressure. When it is first discharged from the air pipe and mingles with the water it has already lost a small portion of its pressure, and as it rises with the column it will expand as the pressure due to the depth decreases, and it will be discharged with the water at a pressure little above that of free air. As the value of the air in the column is in the quantity of water it displaces this displacement will be greater per volume of free air at the top of the column than it will be anywhere below it. As the air is so intimately mixed with the water it must be assumed to take the temperature of the water, or its expansion may be said to be practically isothermal, which is as profitable to the user of the air when expanding as the absence of this condition is unprofitable when the air is being compressed.

Compressed air in the air lift, it has been seen, does not push or force the column of water upward after the lightening of the column, the latter being its only function, and the flow upward is caused by the unbalanced weight of the solid water outside and below the pipe. This suggests at once the necessity of maintaining a sufficient preponderance of pressure from the inrushing water, and this is only secured by the submergence of the pipe or its extension to a sufficient depth below the surface of the water. The height of the lift is the principal factor in determining the submergence required, the invariable condition being that the higher the lift the greater shall be the actual submergence.

As to this particular mistakes are often made. In planning an air lift for a bored and tubed well wherein the water does not rise to the surface but stands constantly at a certain distance below the surface, it is comparatively easy to compute approximately the submergence which should be adapted for delivering the water at a given height, experience rather than theory dictating the figures; but if when the pumping begins the height of the water in the well falls any considerable distance, as it often does, then the proportionate and the actual submergence may be quite inadequate. The submergence will be reduced as many feet as the surface of the water supply falls, and the lift will be increased an equal distance, a double-acting cause of inefficiency. In many cases where a new air lift is installed provision is made for lengthening or shortening the pipes to get the best submergence according to the developed working conditions which could not have been anticipated.

With a given submergence the lift may be greater or less, within wide limits, and the lift will still work, but there is for each case an approximate ratio of submergence to lift which gives the best results, both as to the volume of liquid raised and also as to the air cost, or power cost, of raising it. With a fixed submergence, whether the lift be proportionately small or whether it be as high as possible, the air pressure required will be the same, but while the pressure is thus determined by the submergence the actual volume of air per unit of time, and also the volume of water raised will be influenced and determined by other conditions, especially by the actual volume of air supplied and the resultant rate of flow of the water.

DETAILS OF THE AIR LIFT.

In computations upon the air lift the submergences are stated in percentages. The submergence percentage is that portion of the whole length of the discharge pipe which is submerged, the remaining percentage constituting the lift. Thus with a lift of 100 ft., if the submergence is 60 per cent., the lift, or 100 ft., will be 40 per cent. The 60 per cent., the submergence, will therefore be 150 ft., and the total vertical length of the water or discharge pipe will be 100+150=250 ft. In Fig. 1 A B is the lift and B C is the submergence, both being stated in percentages of the total length A C.

Attention is now directed to the chart or diagram, Fig. 2, from which may be readily determined the volume of free air required with different percentages of submergence to raise 1 gal. of water to different heights from 20 ft. to 1,000 ft. The data embodied in this diagram are practically the same, except in one particular, as the figures of a table given to the public two or three years ago by Mr. E. A. Rix, of San Francisco, who has done much in various ways for general compressed air practice, the table having been compiled by Mr. Geo. H. Reichard of the same city.

The formula by which the table spoken of was computed, is as follows:

$$V=\frac{L}{\text{Log.}\frac{S+34}{34}\times C}$$

Here V is the volume of free air in cubic feet, this being taken in this case as the actual piston displacement o fthe compressor.

L is the lift in feet.

C is a constant, 234, unchanged throughout the computing of the table.

S is the actual submergence in feet, which is obtained as follows:

$$S=\frac{L\times sp}{lp}$$

sp being the submergence percentage and lp the lift percentage.

Say that the lift is 100 ft. and the submergence 60 per cent., then:

$$S=\frac{100\times 60}{100-60}=150$$

Using figures now in the original formula we have:

$$V=\frac{100}{\text{Log.}\frac{150+34}{34}\times 234}=0.584 \text{ cu. ft.}$$

For the air pressure required for any lift, and with any percentage of submergence it is convenient to divide the actual submergence in feet by 2 to get the gage pressure in pounds. This gives enough pressure in excess of that due to the water head to allow for the pipe-friction and other losses.

The one particular in which the computations for our diagram differed from those for the Rix table spoken of was in the constant C. This, as indicated by the line in the upper part of the diagram, instead of remaining the same, 234, all through, was made to decrease gradually as the lift increased. Thus for a lift of 200 ft, our constant is 235, practically the same as that used by Mr. Reichard, but for 100 ft. lift it is 245, for 500 ft. it is 200, and so on. The result of this change is to increase more rapidly the free air per gallon as the lift increases, which seems to agree better with observed results.

The line for constant C in the diagram follows very closely the figures given by Mr. H. T. Abrams, air lift expert of the Ingersoll-Rand Company, in a lecture at Columbia University.

The most striking thing observable in an examination of this diagram is that the volume of free air required per gallon of water lift constantly decreases as the submergence increases. Thus at 25 per cent. submergence and 200 ft. lift, the free air required per gallon is 1.83 cu. ft., while for the same lift and 60 per cent. submergence the free air is 0.88 cu. ft., or less than one-half. In the first case, however, the air pressure required is about 17 lbs., gage, while in the other case the pressure would be 75 lbs., and the mean effective pressure required for the compression of the air (adiabatic) to 17 lbs., would be about 13 lbs., while for compressing to 75 lbs. the mean effective would be 35 lbs. Then comparing 1.83× 13=23.79 with .0.88×35=30.80, it appears at once that the apparent cheapness of deep submergence is nullified or reversed, and other considerations determine what submergence is best.

The air lift is intended for steady work and not for occasional and frequently intermitting service. It is not to be stopped and started at any odd time like a common reciprocating lifting pump. Its efficiency is largely influenced by the correct adaptation, or otherwise, of the sizes of air pipe and discharge pipe to each other and to the rate of air delivery, the latter being entirely controllable, while the inflow of the water adjusts itself to the conditions provided. Nothing is thought of here but the relations of discharge pipe and air pipe to each other, it being assumed temporarily that the water is free to flow into the bottom of the discharge pipe as the "air lift" takes it away. The speed of this voluntary (as we may call it) and uncoercible flow of the water really determines the best working speed, and

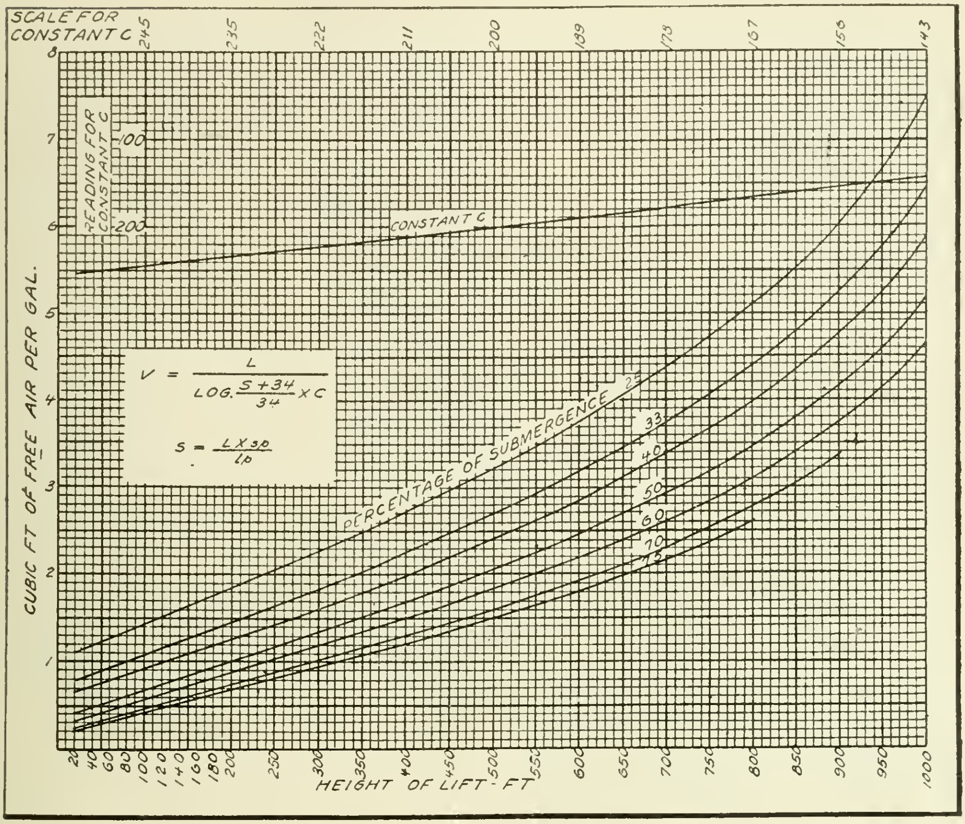


FIG. 2.

also, within certain limits, the possible working speed of the air lift. As might naturally be supposed, the rates of flow in the pipes and the corresponding actual deliveries of water will be more rapid for the low lifts and small actual submergence than for the high lifts and deep submergence, the greater length of pipe causing the greater retarding friction.

While from what has been written above it would seem that almost anyone might install and operate an air lift, there is probably no application of compressed air in which experience counts for so much, and it is recommended that in all cases a competent expert be consulted or employed. In this view of the case it does not seem worth while to lengthen this article by the insertion of tables of pipe capacities and other working data, as these may be obtained from builders of air compressors and others in touch with the business.

LARGE BLAST IN AN OREGON QUARRY

One of the largest shots ever fired in Oregon, for the purpose of securing stone for road building was fired on December 31, 1911, at Kelley Butte Quarry. The charge was placed in a tunnel and laterals were driven into the quarry face, the entire system having a length of 160 ft. Six tons of Special Red Cross quarry powder, divided into eight charges, were placed in the tunnel and were fired by electric exploders, the battery being about 1,000 ft. from the blast. The stone is a cubical basalt, standing upright, with vertical seams, and while comparatively easy to bring down is hard and tough and well adapted to road building. The blast brought down about 30,000 cu. yds. of stone, which is stated to be enough to provide crushed rock for 15 miles of standard macadam road and to keep the crusher plant at the quarry running for a year.

ARTIFICIAL MOUNTAIN AIR

In any large party of tourists who have reached the summit of a lofty peak without effort, by the aid of a modern mountain railway, there are usually a few persons who do not share the general enthusiasm and exhilaration, but lean heavily on their alpenstocks and evidently feel uncomfortable and oppressed. The ascent of a snow-clad peak on foot sharpens the appetite of all true mountain climbers, but it produces the opposite effect on certain individuals.

In both cases the abnormal symptoms are those of mountain sickness, which may be defined, in a general way, as the inability of the organism to adapt itself promptly, or at all, to changes in external conditions. At the extreme heights attainable in balloon ascensions the strongest of men are subject to this disability. Hence it is possible to classify persons according to the heights which they can attain without being affected by mountain sickness, but this classification cannot be absolute because the susceptibility varies with the general condition of the organism.

At one time mountain sickness was supposed to be caused chiefly by the fatigue of mountain climbing, combined with the influence of wind, atmospheric electricity and other climatic factors. This view was apparently supported by the fact that the morbid symptoms are alleviated by rest in sheltered situations, but most diseases are palliated by similar treatment. It was observed, furthermore, that such characteristic symptoms as insomnia and changes in the pulse and respiration often occur in persons carried to great heights without any bodily exertion. More importance, therefore, was attributed to the changes in external conditions, and especially to the diminution in atmospheric pressure at great altitudes and the corresponding diminution in the supply of oxygen. Each of these factors has been made the basis of a theory of the causation of mountain sickness.

In a recent issue of *Die Umschau* Dr. David expresses the opinion that the discomfort which many persons experience at great altitudes is caused chiefly by the diminution in atmospheric pressure. For most persons according to this writer, a sojourn in mountain regions at altitudes up to 10,000 feet is wholly beneficial, and the benefit is due partly to objective and determinable factors and not entirely to the subjective influences of change of scene, environment and occupation.

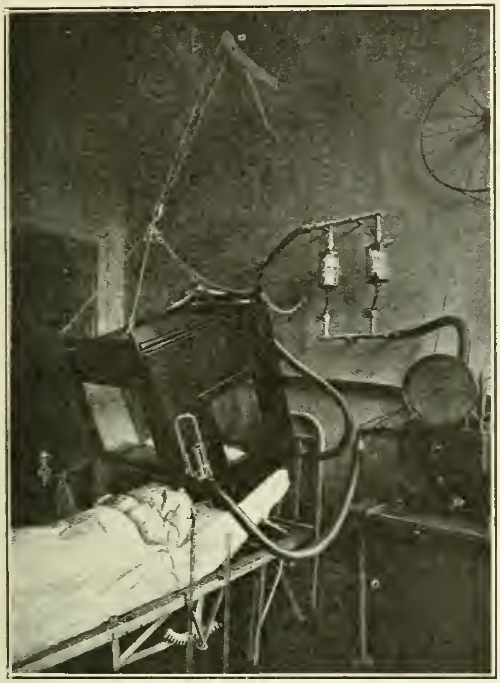
The character of the respiration, for example, is altered. Observation shows that at great altitudes and, in general, in an atmosphere poor in oxygen the volume of air inhaled and exhaled in each respiration is increased, while the number of respirations per minute remains unchanged. In this way a more thorough ventilation of the lungs is effected without greatly increasing the work done by the respiratory muscles. This involuntary, unconscious and effortless deep breathing is quite different, in its character and effects, from deep breathing practised laboriously under an effort of will, which may seriously overtax the heart.

It has also been discovered that the red blood corpuscles, the oxygen-carriers of the body, become much more numerous in the atmosphere of the mountains, and that this increase of these short-lived corpuscles is due to a more rapid production, not to a less rapid decay. The parts of the spinal cord in which these corpuscles are generated reveal, under the microscope, evidence of increased activity.

The deficiency of atmospheric oxygen probably stimulates other organs than the spinal cord to similar compensating activity, and Dr. David regards such stimulation as very beneficial, if not carried to the point of exhaustion. It is for this reason that mental workers are refreshed by moderate indulgence in walking and athletic sports, while men engaged in hard manual labor derive physical benefit from reading and other mental work. In each case comparatively idle cells are forced into action.

This stimulating effect of mountain air is revealed by the balance sheet of bodily receipts and expenditures. It has been found that if the albumen ration which is required to keep the body in normal condition at the sea level is consumed in the mountains the result is an accumulation of albumen, the most important constituent of the muscles and most of the organs.

The theory that the beneficial effects of mountain air are due to its poverty in oxygen receives additional support from Dr. David's discovery that the circulation of blood through the lungs of animals is increased by diminishing the proportion of oxygen in the atmosphere.



ARTIFICIAL MOUNTAIN AIR.

Certain pulmonary disorders in which the lungs are imperfectly expanded and ventilated, and some diseases of the blood in which the formation of new cells is sluggish are characterized by depression of the functions which are especially stimulated by a deficiency of oxygen in the atmosphere. In order to produce this deficiency of oxygen without the diminution in pressure to which Dr. David attributes mountain sickness, he has devised the apparatus herewith illustrated.

The patient's head is inclosed in a large air-tight box provided with glass windows and with a rubber collar so constructed that it makes an air-tight joint about the neck without producing uncomfortable pressure. The box is suspended in such a manner that it can be placed in any desired position. An electrically driven blower and a pair of wash bottles are connected with the box and each other by rubber tubes, forming a closing circuit in which the air circulates continuously, being freed from the injurious products of respiration by its passage through the wash bottles.

By means of a specially constructed valve, shown on the opposite side of the box, and connected with a reservoir of oxygen, a quantity of oxygen exactly equal to the quantity consumed in respiration is continuously admitted. The proportion of oxygen in the air can be reduced to the desired degree at the outset by drawing off some of the air and admitting nitrogen or some other inert gas through this valve, or gradually by connecting the nitrogen reservoir with the valve without drawing off air so that the oxygen consumed is replaced by nitrogen.

The ordinary atmospheric pressure is maintained in the box. The composition of the air may be determined, from time to time, by the ordinary methods of gas analysis, or a self-registering apparatus may be constructed to give a continuous graphical record of the proportion of oxygen. An air-tight cabinet which the patient can enter and in which he can move freely may be used to advantage instead of the box surrounding the head. A cabinet of this sort will soon be installed in a German sanitarium.

The results of the therapeutic applications of this apparatus that have been made, thus far, appear to corroborate the theory on which it is based. It does not aspire to rival the Alps, but is designed merely to produce some of the beneficial effects of mountain air without its disadvantages, especially in cases in which great altitudes are positively contra-indicated.—*Scientific American.*

THE SPROUTING OF A GREAT PLANT

The following, by E. J. Edwards, is from "New News of Yesterday," in the Evening Mail, New York. It is presented here for whatever it may be worth, and it is at least worth reading.

Shortly after the Civil War Samuel Ingersoll [his name was Simon] of Stamford, Conn.—the first man in America to adapt a motor to a wagon—[which is doubtful]—chanced to meet on a railway train between Stamford and New York City a contractor who complained of the delay on an important job by the difficult character of some of the rock-cutting to be done. Finally the contractor said:

"Ingersoll, you have done a good deal of inventing. Now, I wonder whether you cannot invent a machine which will take the place of hand labor in drilling rocks? I don't see why it cannot be done."

Ingersoll seemed for a moment completely absorbed in an idea that had suddenly come to him. At last he said:

"I think I see a way by which I can make exactly what you want. You want a machine driven by power which will drill holes rapidly in rocks."

"That is exactly what I want," said the contractor. "And I'll tell you what I'll do with you. If you will make a machine of that kind, and show me the model so that I can see how it works, I will, if it is satisfactory, give you $100 for it."

"I'll do it," Mr. Ingersoll replied; and in the course of two or three weeks he carried to this contractor not merely the model of his apparatus, but one which had been actually built and was ready for service. A thorough test was made of it. Certain improvements were suggested and adopted, but the fundamental idea of the invention—Ingersoll's original conception—has been preserved from that day to this.

This rock drill is one of the inventions of the last half of the nineteenth century, which have served to change the face of the globe by opening up regions to civilization which were at the time of our civil war practically unknown. It made possible the very rapid railway construction in the mountainous districts of this country which began shortly after the close of the civil war. But for it the Panama canal would not now be nearing completion with such startling-like rapidity. It enabled New York to secure a new water supply from the heart of the Catskill mountains, to cut a tunnel through the solid rock a thousand feet below the surface of the Hudson river in little over a year's time.

It has been estimated by competent engineers that the rock drill has increased the wealth of the world within the past forty years by hundreds of millions of dollars. More than one leading engineer of the world has linked Mr. Ingersoll's name with that of George Westinghouse, that of Sir Henry Bessemer and that of Thomas A. Edison—all inventors of apparatuses which have been able to consummate colossal constructive triumphs in the last half century. The only money Samuel Ingersoll ever made out of his greatest achievement was that insignificant $100.

THE AIR COMPRESSOR AND THE DIESEL ENGINE

The air compressor is an important and responsible auxiliary of the Diesel engine, especially when the latter is employed in marine propulsion. The following is a brief sketch of the motor equipment of the Selandia, which we suppose should be called an "oiler" instead of a "steamer," built in Denmark and recently started on its first voyage to Siam.

The main engines, built, like the vessel itself, by Burmeister & Wain, of Copenhagen, consist of two sets of 4-cycle Diesel motors, each with eight cylinders 20.8 by 28.7 inches, giving together 2,500 indicated horsepower at 140 revolutions per minute. At first sight their general appearance resembles that of ordinary reciprocating steam engines of the inverted marine type, but on inspection differences are quickly revealed, such as the closed-in crank pit and the long valve rods which stretch up from the valve gear to operate the four valves —air admission, fuel oil, starting, and exhaust —that are placed on the tops of the cylinders. The cam shaft, which actuates the valves, is driven at half engine speed through a small spur wheel on the crank shaft, which gears into a larger wheel mounted on an intermediate shaft. This latter, by means of cranks and connecting rods, drives a second shaft placed higher up, which in turn, by gearing, works the cam shaft. For each cylinder there are two sets of four cams; and according as one or other of these sets is in contact with the valve rods the direction of the motion is ahead or astern. When the engine is at rest the valve levers stand in an intermediate or neutral position clear of the cams, but when a start has to be made the cam shaft is moved an inch or so longitudinally to the right or left according to the direction of motion required and the valve levers are dropped upon the cams by a small compressed-air engine mounted on the front of the engine casing. Reversing from full speed ahead to full speed astern can be accomplished in less than 20 seconds.

Compressed air, at a pressure of 300 pounds per square inch, is also used for actually starting the engines. While the cam shaft is being got into the proper position the starting lever is in the neutral notch. It is then moved forward, admitting compressed air to the cylinders, and when the engine has attained the necessary speed, fuel oil is admitted by moving it still farther forward, the starting valves then closing themselves automatically. The amount of oil, and therefore the speed, is determined by the position of the starting lever in a series of notches at the back of the quadrant. The oil is forced into the cylinders at a pressure of something like 1,000 pounds per square inch by a pair of pumps placed above the starting lever, each pump serving four cylinders, and it is taken from a couple of service tanks in the upper part of the engine room casing, to which it is raised by a pump driven by compressed air. Each of these tanks holds sufficient for 12 hours' normal work. An Aspinall governor is fitted to cut off the oil from the cylinders should the speed of the engines become excessive, as by racing of the propeller.

For lubrication, oil is pumped through the main bearings, crank shaft, connecting rod brasses, connecting rod, cross-head brasses, and piston rod to the top of the piston rod, whence it is returned through the piston rod and is ejected upon the guide faces. These being cooled by the water circulation, it is there cooled, and if further cooling is required it can be pumped through an oil cooler. A special lubricating arrangement is provided to supply oil to the surface of the pistons.

For furnishing the necessary compressed air there are two three-stage compressors, one behind each of the main engines, driven by two auxiliary Diesel engines having four cylinders and developing 250 horsepower at 230 revolutions per minute. These deliver air at 300 pounds per square inch, which is stored in four large cylindrical tanks. For injecting the fuel air is taken from these and raised to 900 pounds pressure by compressors fitted at the forward end of the main engines and driven from the crank shafts. Either of these compressors is able to provide sufficient for both main engines, but to meet the emergency of both being out of order, there is a Reavell compressor driven by steam obtained from a small donkey boiler. This is fired with oil fuel, and also serves for heating the radiators in the ship. Finally, arrangements are made so that the exhaust valve of one of the cylinders of the main engines can be removed and replaced by a delivery valve; that cylinder then acts as a compressor, if the fuel be cut off from it, and delivers air at 300 pounds pressure. Evidently, therefore, the total failure of the compressed-air supply is an exceedingly remote contingency.

Besides driving the air compressors the two auxiliary Diesel engines each work a dynamo generating current at 220 volts. For lighting purposes this is transformed down to 110 volts, but it is used at its original voltage for driving most of the auxiliary machinery, including two pairs of lubricating pumps, circulating water pumps, hot and cold water sanitary pumps and bilge pumps, a carbonic acid refrigerating machine, the capstan, all the winches on deck, and the steering gear, which is on the Hele-Shaw Martineau system. Compressed air is employed for the ballast pump, and also for the siren, being taken for the latter purpose from the second stage of the main compressors at a pressure of about 120 pounds.

QUICKEST TRAIN BRAKING

The quickest way for a person in a car of a passenger train to cause the stoppage of the train is to exhaust air pressure from the brake pipe, and for this the conductor's valve is provided. To neglect this means, and, instead, to signal the engineman to stop, interposes an appreciable delay. This is wholly unnecessary, if the men in the cars are competent to manage the conductor's valve; and in case of a danger which demands the quickest possible stop the delay may mean an aggravation of the danger; in other words, it may be important to reduce the delay as much as possible. We have long since abolished the uncertainties of the old bell-cord, but we have not done away with its slowness. With the air signal there must be an interval between the two blasts of the whistle, and another interval to enable the engineman to assure himself that the signal does not mean something else than "stop." And with a fast train every second is precious. These considerations are illustrated in an accident which happened recently to one of the fastest trains on an eastern trunk line. The electric light dynamo under one of the cars became loose and dropped so far as to catch on the plank at a highway crossing, which resulted, after running a few hundred feet, in the dynamo being thrown out to one side and across the adjacent main track. The two trucks next back of this dynamo were badly damaged, but did not run off the track. Riding in this car was the conductor of the train, and, feeling the severe jar, he grasped the whistle cord and gave the two pulls necessary to convey to the engine a stop signal. Seeing that the engineman did not respond, he gave two more blasts: and then instructed the porter to pull the conductor's brake valve, which was done. But the disturbance caused by the accident was also heard or felt by a brakeman in the next car in the rear, and he also pulled the whistle cord twice; and these two pulls, coming between the first two and the second two given by the conductor, made six in all, and six blasts of the whistle was what the engineman received. This is the signal for increasing the supply of steam to the heating pipes, and that was what the engineman did. The whistle was blown a seventh time, however, and so the engineman, although on looking back he could see nothing wrong, concluded that something was the matter, and applied the brakes. By this action, or that of the porter, the train was stopped. From the time that the conductor first pulled the whistle cord it ran a mile and a quarter.—*Railway Age Gazette.*

A COMPRESSOR KICK

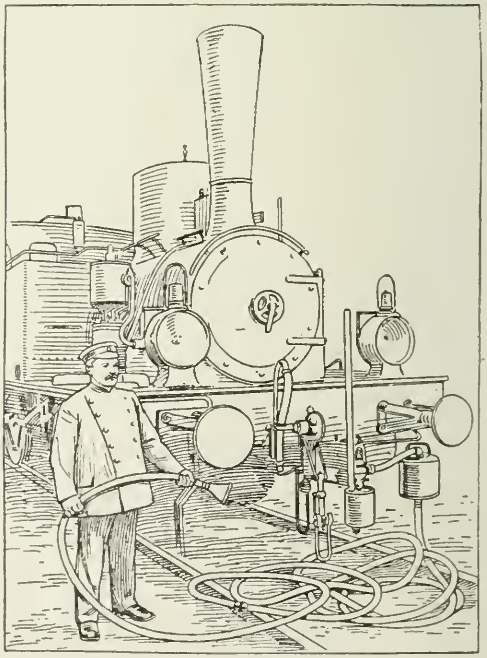
We have in use an old compressor which had punched a hole through the air cylinder head about 4 in. diameter, and this had been closed by bolting a plate over it. One day a slight leakage appeared around this plate and I said to the youngster, "John, put a new gasket under that plate when we shut down." Accordingly, at the noon hour, John took a wrench, removed the cap screws that hold the plate, and, standing directly behind the plate, started with a chisel to pry the thing loose.

Right there things happened rapidly. When John found himself he had displaced a large pane of glass in the window just behind him and was wedged in so tight that it took both of us to get him out. When he came to himself, his first remark was, "Who'd a thought that that little plate could kick so hard?" The trouble was a leaky discharge valve, which let pressure back up from the receiver tank into the compressor cylinder, and I noticed that whenever anybody afterwards had any repairing to do on the compressor, he let the pressure off the receiver before starting on the job.—*Practical Engineer.*

A LOCOMOTIVE VACUUM-CLEANER ATTACHMENT

An apparatus by means of which a locomotive is converted into a vacuum-cleaning plant is shown in the accompanying illustration. It comprises simply a suction chamber attached to the injector valve of the locomotive, a steam trap for the condensation of water, a dust collector, which is kept partially filled with water, and the necesary amount of hose and types of suction tips or nozzles. The steam trap and dust collector are connected by means of a hose of large diameter, and the suction hose is attached to the bottom of the dust collector.

When the injector valve is opened the live steam passes the opening of the suction chamber and creates a vacuum therein, which produces the suction, drawing the dust and dirt into the dust collector where it is retained by the water. The air, after unloading its burden of dirt, then passes into the steam trap and is exhausted into the atmosphere. With a sufficient length of hose, several passenger coaches can be vacuum cleaned by simply backing the locomotive up to one end. The apparatus is used on one of the German railways. —*Popular Mechanics.*



A RAILROAD VACUUM CLEANER.

A COMPRESSED AIR GROUTING MACHINE FOR GROUTING TUNNEL LINING

Fig. 1 shows the essential details of a grouting machine in which the grout is mixed and from which it is ejected by compressed air, while Fig. 2 shows a battery of these machines at work grouting the concrete lining of the Walkill Tunnel, which is one of the pressure tunnels in the Catskill aqueduct being built to supply water to New York City. The specifications for these tunnels provide that all larger voids behind the concrete lining shall be dry packed and that minor voids and crevices shall be filled with grout either through pipes built into the lining wherever need of them can be foretold, or through holes drilled after the lining is placed. The proportions of the grout mixture is to be determined by the engineer, but the character of the sand is specified: "It shall be clean sand of such fineness that 100 per cent. will pass a sieve having 64 openings per square inch and 45 per cent. will pass a sieve having 1,600 openings per square inch.

There is a cylindrical steel tank with a conical hopper bottom and a flat top having a charging door. The charge of cement, sand and water is placed in the tank and the compressed air is directed through the bottom, running upward through the material and mixing it by agitation. When the batch has been sufficiently mixed the air pressure is diverted into the top of the mixer and passes the grout out through the discharge pipes, whence it is delivered by hose to the cavity being grouted.

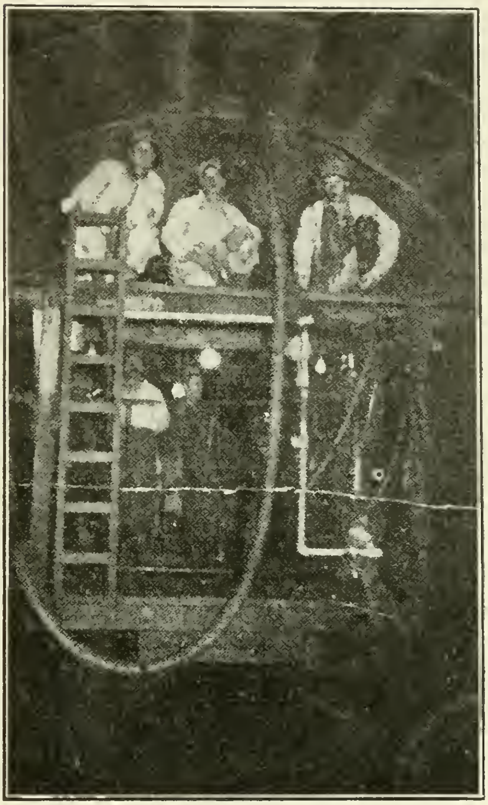


FIG. 2.

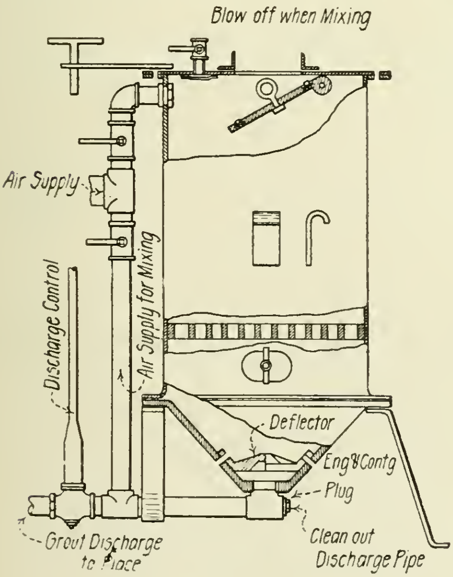


FIG. 1.

In the Walkill tunnel a special outfit of mixers was installed by the Degnon Company, contractors. It consists of four Ransome-Canniff grout mixers and an air compressor set up on a heavy platform on wheels. The mixer nearest the compressor is used exclusively as an air receiver. The other three mixers are connected up in a battery, but the end one is so connected that it can be shut off from the other two mixers and used separately. By this arrangement the three mixers can work together under any pressure up to 300 lbs., and if necessary the end mixer can be cut off from the other two and worked separately under 300 lbs. pressure, while the other two mixers continue to eject under 75 and

100 lbs. pressure. This has resulted in a large saving of time and expense. It should be added that the rear end of the platform is used to pile bags of cement upon and from this point the cement is emptied into the three hopper-like affairs above each mixer. With these grout mixers the contractors are grouting 24 hours a day divided into three 8-hour shifts, and an average of 200 or 300 lineal feet of tunnel has been grouted per day.

On the Rondout pressure tunnel grouting is also in progress, using the same type of grout mixers; a battery of three mounted on a car is connected up to two 9½x5x10-in. air compressors. The compressors are used to raise the pressure to 350 lbs., when necessary, the normal direct-line pressure being only 100 lbs. An air reservoir made of a piece of 12-in. wrought iron pipe 5 ft. long is used between the compressor and the tanks. The grout used was generally a 1 to 1 mix with sufficient water to lift it into place.

The grout mixer described is known as the Ransome-Canniff mixer and is manufactured by the Ransome Concrete Machinery Co., Dunellen, N. J.—*Engineering and Contracting.*

COMPRESSED AIR PLANT FOR MINES

BY LUCIUS I. WIGHTMAN.

Of recent years a noticeable tendency in mining work is toward the adoption of air compressors of high economy, both for coal and for metal mining service. At first thought it would not appear necessary for the operator of a coal mine to consider fuel economy seriously, but the facts in the majority of cases are to the contrary; and even where the cheapest grade of coal is used as fuel at the coal mine, managers are taking care to make it go as far as possible by means of high-efficiency steam-driven compressors.

Increasing use of high-duty compressors in the metal mining industry is the direct result of the exhaustion of rich ore bodies and the necessity for mining and treating low-grade ores which would have been considered not worth handling a decade ago. The prevailing low market price of metals, coupled with this steady movement toward large-volume, low-grade production, has forced mine managers to apply the best cost-reducing methods to their operations. And since compressed air is the main reliance of the mine operator, he is giving closer attention to the problem of more economical air compression, to be realized only by the adoption of the most up-to-date and efficient compressor types. His problem is further complicated by the high cost of fuel prevalent in most metal mining districts. And even where electric power is available for mine service, the rates are usually so high as to demand every effort toward utilizing to the utmost each electrical horsepower delivered to the compressor shaft.

FEATURES OF THE STRAIGHT LINE COMPRESSOR.

This type of compressor, because of its simplicity, compactness, ease of transportation and installation, and "fool-proof" quality, will always find a place for development work in new properties. Some builders are manufacturing straight line compressors with high-duty features, such as compounded steam cylinders and even Corliss steam valves; and compounded air ends are so common as almost to call for no comment. But the difficulty of getting economical regulation under widely varying load, such as is characteristic of mining work, without flywheel interferes with the economical refinement of such machines. Above 75 or 80 per cent. load it may realize the fuel economy to be expected from steam compounding and be economically self-regulating; below this limit it must either be regulated by hand or be left to blow off excess air through the safety valve, so that the double-tandem-compound compressor, whether either Meyer or Corliss steam valves, is but little more efficient on partial loads than a simple steam machine.

DUPLEX COMPRESSORS FOR MINES.

Duplex compressors are rapidly dominating the field of mining service. The best modern duplex double-compound compressor maintains practically a uniform fuel or power economy over a wide load range, and will, because of its quartered cranks, run down to a low speed with only the slightest departure from the best efficiency. Where a maximum compressed air capacity must be instantly and automatically available, with an average daily load factor of around 50 per cent. and probably less, the duplex compressor offers an excellent solution of economical operation.

A notable comparison of the economy of the duplex compressor with the straight line compressor was recently reported from a Pennsylvania anthracite mine, where coal at $0.40 per ton was burned under the mine boilers. A large double-cross-compound Corliss steam compressor replaced 2 Meyer valve tandem-compound straight lines of equivalent combined capacity. The first few months of operation showed savings in fuel, water and labor realized by the new machine indicating a yearly saving of a little less than $9,500, with the Corliss compressor running noncondensing. A condenser has since been installed so that still greater savings have been realized, leading to a duplication of the equipment.

In the case just cited, comparison is between a splendid compound Corliss steam 2 stage air unit, and 2 simple-Meyer-steam, 2-stage-air straight line compressors, but another example —outside the mining field, but still typical of what might be realized in mining work—will furnish further evidence.

One of the contractors on the Catskill Aqueduct construction, New York, operated 2 different types of compressor plants on 2 sections of his work. One consisted of 4 double-tandem-compound Corliss-steam air compressors. The other comprised 2 double-cross-compound Corliss-steam air compressors, each with a capacity almost identical with that of each straight line unit in the other plant. Both plants were operated under identical steam and air pressures and vacuum, and under almost identical load conditions.

At the end of 16 months, the contractor needed more air; and to determine whether to buy straight line or duplex units for his addition, he went back over the fuel costs of his 2 plants for the previous 16 months. He found that his fuel cost for the double-tandem-compound compressor plant had been $58,000 or $5.92 per cu. ft. of free air for 16 months. While the coal cost at the double-cross-compound compressor plant had been $15,000 or $2.90 per cu. ft. of free air for 16 months. The figures showed that, had he been using the duplex compounds throughout, he would have saved $29,596 in cost of coal alone during the 16-month period. And the added saving in labor, oil, supplies and depreciation would probably have brought the total up to $40,000, or a rate of $30,000 saved a year. The contractor's order for added equipment was for duplex compressors.

The same ratio of saving could be realized in mining service, whether in coal mining where fuel is cheap, or in metal mining where coal is dear.

POWER DRIVEN COMPRESSORS

While the foregoing has referred only to steam-driven compressor units, modern mining practice is tending toward a standardization on the duplex power driven type also, for mining service, for much the same reasons that have given the steam-driven duplex the preference. The power-driven mine compressor is almost invariably electric driven. The straight line type cannot be direct-connected; the duplex, on the contrary, offers ideal conditions for direct shaft drive, and the writer believes that it is only a question of time when this type, in comparatively large capacities, will predominate on purely economical grounds, as it minimizes losses between motor and compressor cylinders.

With large-capacity, constant-speed, power-driven units, the only efficient means of regulation is in rendering ineffective, in delivery of air, part of the piston displacement. To do this on a compound straight line causes unbalanced conditions prejudicial to good service and wearing power. But the duplex permits this to be done without any sacrifice of the pressure equilibrium of the machine, and regulation under a variable load factor is smooth and easy on the unit.

AIR TRANSMISSION SYSTEM.

Now, having taken due care to produce compressed air at lowest cost, shall the seeking after economy in the mine air plant end here? With the drills, hoists, pumps and other air operated devices of the mine, this paper has not to do. But the delivery of compressed air from compressor to machine very properly is a function of the compressed air plant. Needless to expatiate upon the folly of making air cheap, and then sacrificing the gain through a leaky, inefficient insufficient distribution system.

First, the receivers—they are the flywheels of the air power system, the buffers interposed between the sudden, irregular drafts of the air machines and the steady pull of the compressor. Let the receiver capacity be ample; here, if anywhere, extravagance is a virtue. Let the receivers be in the cool out-of-doors, rather than in the hot engine-room. And remember that receiver drain cocks were provided to be used.

If continued trouble be experienced from freezing up at the exhaust of the air machines, put in an after-cooler to dry the air. For the water vapor which has been freezing at the machines will then be condensed, precipitated, and can be removed from the air before it enters the pipe lines. More than this, an aftercooler will send only cool air into the pipe lines, so that expansive and contractive movements due to carrying hot air and later cooling will not give rise to a leaky distribution system. And air dried in an aftercooler will prevent accumulation of water in the air lines, with "water hammer" and loss of transmission economy.

For the pipe lines, figure the diameter by the most generous formula for capacity and pressure—and then use pipe a size or two larger than is indicated. And remember that the maximum capacity must be provided for, whater the average load factor that may be anticipated. For it is at moments of maximum demand that the air lines will be put to the severest test; and what shall it profit a mine manager if he gain the highest economy at his compressor and then lose most or all of his saving by insufficient air pressure at his drills? Pressure is the vital thing in a rock drill or stoper; and while "air cannot be lost" in a tight pipe line because loss of pressure means increase of volume, it is the pounds-per-square-inch on the drill piston which drives the drill hole in the least time, which means the least labor charge.

So let the pipe lines be designed to deliver both volume and pressue—volume determining the number of machines that can be used, pressure determining the amount of work each machine will do. Abhor the short-turn elbow; cultivate the wide-bend habit. Air in motion finds as much difficulty in turning a right-angled corner as a running man or a mule. Let the pipes and fittings underground be protected so far as possible from acid, water, rerailed cars, and falls of rock. Let drain cocks be placed, and used, in the low places. Keep a good big air pipe always right up to the drill manifold; let the air hose be the last and smallest element in your distribution system.

And keep all joints tight. Test the pipe system at night, or on a Sunday, when all the machines are known to be stopped, by running the compressor until normal pressure shows on the receiver gage. Then see how many turns of the compressor are needed to maintain that pressure. This will show the "leakage load" and represent the waste of power going on every minute that pressure is on the system. One manager, who was cursing the voracious air consumption of his drills, was induced to make this test, and found that he had to run his machine steadily at 25 per cent. normal speed, to keep up pressure on an absolutely unloaded pipe system. He decided it was cheaper to stop the leaks in his pipe lines than to install more compressor capacity and more drills. There are doubtless many others waiting to make this same discovery.

AN INTERNAL COMBUSTION COMPRESSOR

The illustrations which we here reproduce from Engineering, London, show an internal combustion air compressor with a free piston which has been constructed and actually operated by Signor Guiseppe Matricurdi, Lago Maggiore, Italy. Fig. 1 is from a photo of the compressor and connections. Fig. 2 shows the construction and operation diagrammatically, and Fig. 3 is a complete duplex indicator diagram.

The cycle of operations in such a compressor is as follows:—A heavy piston is propelled from one end of a cylinder to another by the explosion of a charge of gas behind it. During its motion it expels the air in front of it through a port, and thence through a non-return valve into a reservoir. The piston near the end of its travel over-runs the port, and compresses into the end of the cylinder a fresh charge, which is exploded in its turn, shooting back the piston to the other end. In its passage the piston compresses and discharges into a reservoir the air in front of it, as before. The piston is thus shot to and fro between the two ends of the cylinders, drawing in air on one side, and compressing and discharging it on the other. Each end of the cylinder is closed by a large valve, through which the air to be compressed enters the cylinder. A cap arranged over each cylinder end, as indicated, causes all this air to pass between studs cast on the outside of the cylinder, which is thereby cooled. The stem of each of these air-admission valves is hollow, and terminates in an enlarged end as shown. Just beneath this enlargement a number of fine holes are drilled through the wall of the valve stem, which, when the main valve is closed, are in communication with the fuel-pipe *a*. If,

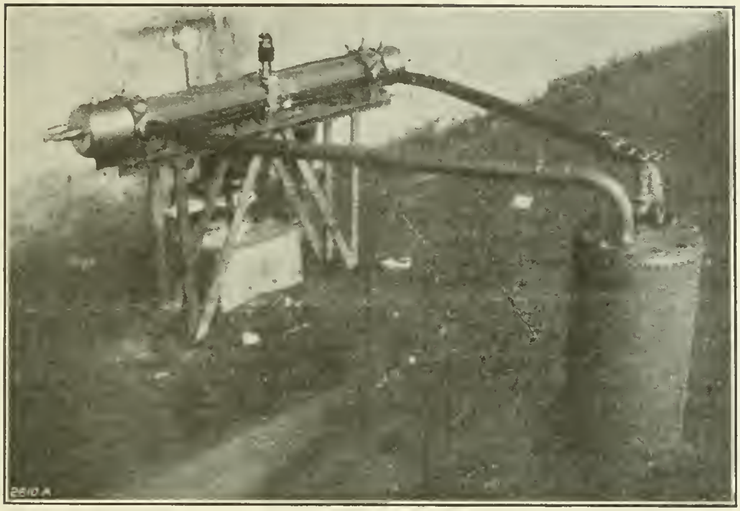


FIG. 1.

however, the main valve opens, these small orifices are masked, so that no fuel can enter from the fuel-pipe during the process of drawing air into the cylinder. The supplementary openings shown at *b b* may be used to supply a charge of compressed air in starting up.

The working of the device is as follows:—Supposing the piston at the left-hand end of the cylinder, with a charge between it and its cover. This charge is fired by the rise of temperature due to the previous compression, and expands along the line A B of the indicator diagram, Fig. 3. When the piston reaches the point corresponding to B, it uncovers the port in cylinder wall, and some of the gases behind it, being at a higher pressure than those in the reservoir, pass through this port into the latter, the pressure of which is represented by the point C. As the piston moves forward the pressure falls down below that of the atmosphere, as represented by the point D, and a suction stroke is made, which terminates at E. The piston then begins its return stroke. The inlet valve being closed, and the pressure inside the cylinder being less than that of the reservoir, a charge of petrol or oil is sprayed through the fuel-valve until the return of the piston has compressed the entrapped air to F. The pressure then remains constant and air is discharged into the cylinder until the piston masks the discharge port at a point corresponding to G on the diagram. Compression then commences and continues along the line G H until the temperature rises

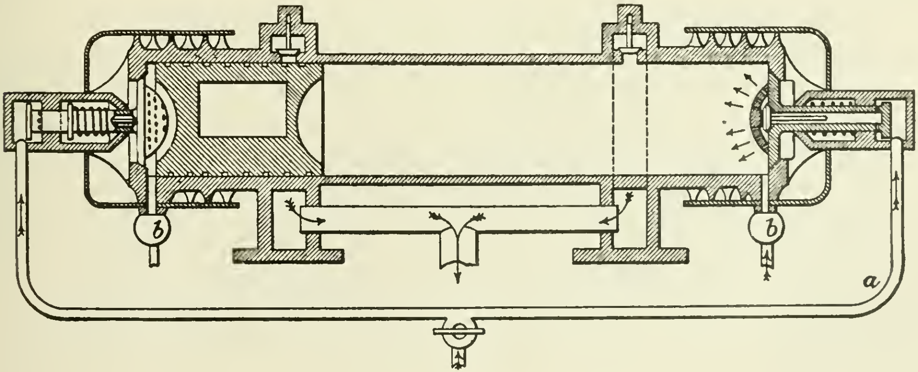


FIG. 2.

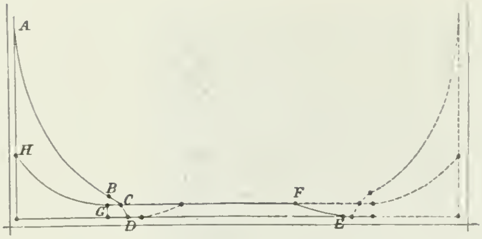


FIG. 3.

sufficiently to ignite the charge, when a return stroke is made. The cycle of events and the indicator diagram is exactly the same for the right-hand side of the cylinder as for the left. The fuel charge is, it will be seen, not admitted until after the air-inlet valve has closed. It thus remains near the head of the cylinder, and is not wasted through the discharge-pipe to the reservoir. The whole of the products of combustion pass into the latter, raising the temperature of the mixture there and increasing its available energy.

A PNEUMATIC STREET CLEANING MACHINE

The illustrations here reproduced from the pages of Engineering & Contracting, show the Furnas pneumatic street cleaning machine as described by Mr. C. A. Tripp, Indianapolis, in a paper before the Indiana Engineering Society.

The machine is an automobile adaptation, the propelling motor being used also for actuating the sweeping device. The sweeping hood is shown resting on the street surface. This is preceded by a set of coarse brushes, or rather scratchers, which loosen any dirt that may be stuck to the street surface. The dirt is taken up and deposited in the dirt box, the bottom of which consists of two doors which can be dropped for depositing the load. The small boiler shown furnishes a supply of steam which dampens the dirt, aiding in its separation from the air, and also forms it into a dustless mat or cake in the box, so that no dust is made when dumping or when loading into wagons.

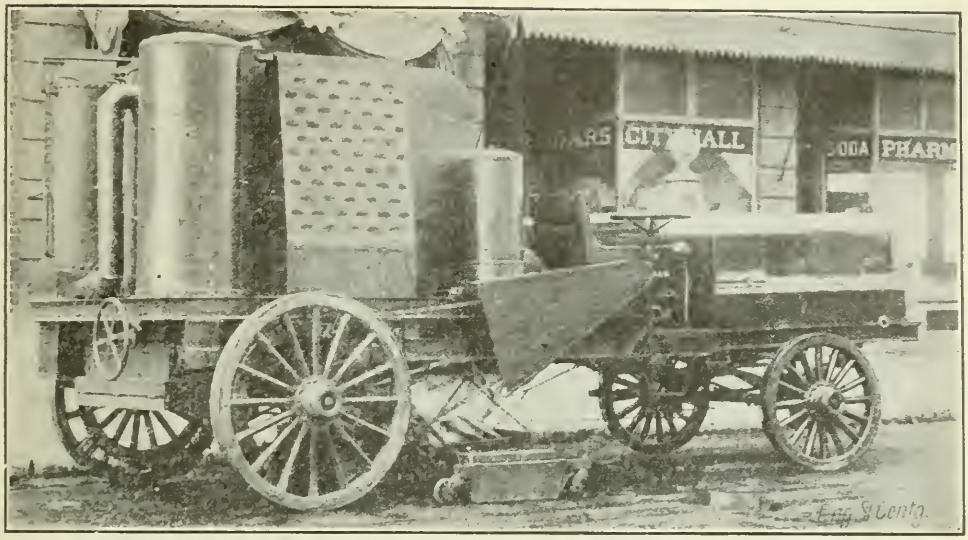
The sectional view, Fig. 2, shows the air circulating system, which is the interesting and all important part of the machine. The general plan is that the air used for sweeping is recirculated, being used over and over again, with the exception of a small amount which is taken out to provide for leakage, as will be explained later.

The sweeping hood consists of an inner and an outer portion. The outer portion is inclosed by short curtains or lines, made of canvas, to which small plates of iron are riveted. These plates serve to weight down the canvas and also to take the wear due to dragging on the street. They are sufficiently light, however, to pass over the dirt and not act as a brush or scraper. The inner portion is separated from the outer portion on the front side by a similar line, but on the rear side by a metal strip which runs at a distance of about ½ in. from the street surface. This is the real sweeping point. The air comes down in the outer portion at a comparatively low velocity and at substantially atmospheric pressure. The inner portion is under the full suction of the fan. The air rushing through this narrow opening at high velocity and in a direction practically parallel with the street picks up the dirt, which is then carried up through the opening in the center of the inner portion.

As shown this opening is connected directly to the fan suction. From the fan the air and dirt enter the centrifugal separator, which is directly above the dirt box. Here a small amount of steam is blown in, as previously described. After the air has deposited the dirt picked up from the street it leaves by the center tube and returns directly to the outer portion of the hod. Within the center tube by which the air leaves the separator is a small pipe, which is open at the lower end. A small amount of the air leaves by this pipe, which leads to the ash pit of the boiler. The amount of air taken out through this pipe is equal to the inward leakage to the outer portion of the hood.

The pressure in the separator, and hence the amount of air leaving by the small pipe, is controlled by the damper shown in the passage between the separator and the hood. Indirectly this determines the pressure in the outer portions of the hood, which is maintained at or slightly below that of the atmosphere, so that any leakage is inward, thus preventing dust.

The small steam boiler serves a double purpose. Steam added to the dirt and air as it enters the separator, increases the weight of the dust particles and thus aids in the separation. It also dampens the mass of dirt so that



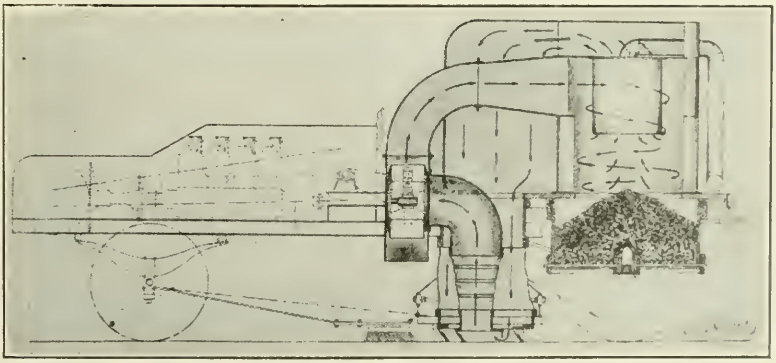
PNEUMATIC STREET CLEANING MACHINE.

dust is prevented when dumping. The air returning to the hood, and therefore the air leaving the separator by the small off-take pipe, carries a fine dust which it is very difficult to separate. The fire in the boiler serves as an effective filter for removing this from the small volume of air which must be discharged, while the air acts to produce draft for the fire.

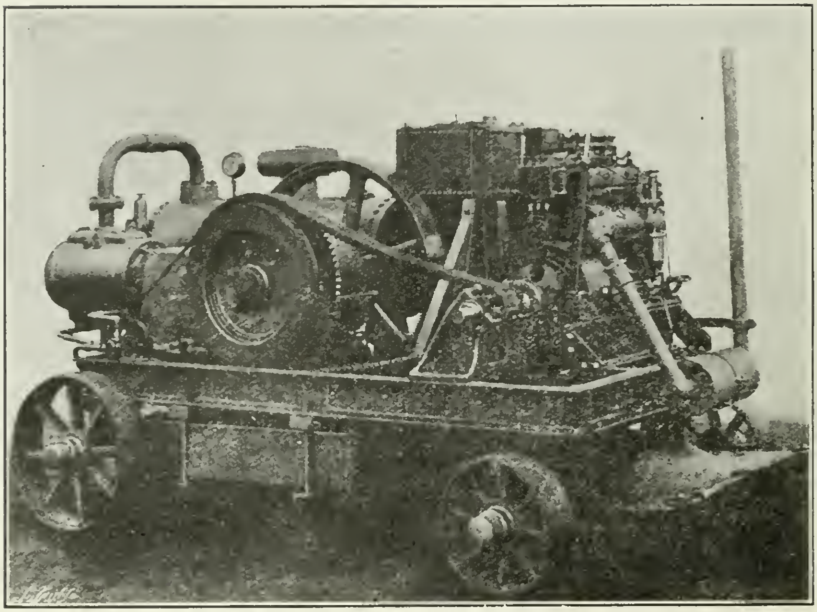
The power equipment consists of a 6x6 4-cylinder engine, located at the forward end of the machine. The sweeping fan is driven from the rear end of the engine shaft through a cone clutch and spur gears running in oil. The power for propulsion is taken from the front end of the shaft and transmitted through a friction drive and differential jack shaft to the rear wheels. The maximum speed of travel is 5½ miles per hour, which may be reduced by the friction transmission, as required by the condition of the street being swept.

The machine is operated by two men. The driver controls the steering, and propulsion and fan speeds. The operator controls the pressures in the air system, raises and lowers the hood as required by means of the two levers shown, fires the boiler and dumps the dirt.

Air nitrates, produced electrically in Norway, according to Consul General Bordewich, are sold for export at an average of $39 per ton at the works, exclusive of packing.



SECTION OF STREET CLEANING MACHINE.



A PORTABLE AIR COMPRESSING PLANT

The half tone shows an interesting portable air compressor and drive in use in England for driving pneumatic tools and other work of a temporary character. It is self-contained and complete comprising essentially an Ingersoll-Rand compressor and a Parsons kerosene engine with their appurtenances mounted on a truck with wide tread wrought iron wheels, the over-all dimensions being 7 ft. 10 in. by 4 ft. 1 in.

The compressor cylinder is 8 by 8 in., and at 210 revolutions delivers 80 cu. ft. of free air per min. at 80 lbs., gage, into a horizontal receiver 60 by 21 in. The compressor has an automatic intake controller and flood lubrication. For cooling the cylinder there is a water tank under the truck and a small pump for circulation. Power is transmitted from the engine to the compressor by a Westinghouse Morse rocker chain and a special spring tension wheel.

The motor is a three cylinder enclosed engine, the cylinders being 4½ in. base and 6 in. stroke, developing 21 horse power. The engine may be started either by injecting a small quantity of gasolene or by employing a blow-lamp. The charge is fired by a magneto having a patented timing drive whereby the requisite amount of advance or retardation of the point of ignition is secured. The speed is controlled either by a governor or by hand. An all-metal clutch is provided between the engine and the chain pinion, allowing the engine to be started without the compressor load.

Water circulation is provided for cooling the motor, a Parsons pump being fitted to the engine for the purpose. The pump draws its supply from the bottom of the radiator and after passing the water around the cylinders delivers it to the top of the radiator which has a large fan in connection with it. A silencer is used discharging the exhaust vertically. The engine is started by a detachable crank on the end of the shaft.

Swiss railroad tunnels are reported to number 415 and have a total length of 103 miles, by the "Revue Générale des Chemins de Fer." The principal ones and their lengths in miles are: Simplon, 13.00; St. Gothard, 9.50; Lötschberg, 9.25; Mount Cenis, 8.50; Arlberg, 6.50; Ricken, 5.50; Montier Granges, 5.50; Tauern, 5.50; Hauenstein, 5.00; Mont d'Or, 4.00; Albula, 3.75; Weissenstein, 2.50.

COMPRESSED AIR IN BOILER SHOPS*

A boiler shop without air tools is almost unthinkable in these days. The purpose of the present paper is to run over, briefly, the production, transmission and use of air and the general operation of air tools.

The character and quantity of shop output must determine the equipment. Such questions as these arise at the beginning: Is the output standardized, and is the work mainly duplication in small or larger quantities? Is it special, each case almost individual, or does it fall in the much larger class of jobbing, part repair and part manufacturing? A discussion of the general subject will take its shape according to whether it is to cover an existing plant or the planning of a new installation.

THE COMPRESSOR.

Conditions change and the demands for air grow, so that an equipment which in the beginning may be quite adequate and proper in time becomes inefficient and insufficient. The wide range of uses to which compressed air lends itself is not at first fully appreciated, and only the most experienced can approximately estimate the demands which later will have to be met.

General experience shows that for best all-round work the proper pressure at the point of application is from 90 to 100 lb., and in some cases even slightly higher; however, 100 lb. at the tool will meet every requirement of 99 cases out of 100.

To give 90 to 100 lb. at the tool will call for a terminal or receiver pressure of from 100 to 110 lb., depending on the piping or transmission system, to be discussed later. We now have the first production factor—pressure. Next comes the question of volume of air required, and this in turn necessitates a careful study of present and future requirements: What types of tool; the number of each to be operated; the probable number operated at the same time; the average time of operation of each; what special appliances will be installed; is air to be reheated, and what provision is to be made for growth?

Fairly accurate tables are obtainable giving the air requirements for all standard tools and machines, and data are available from which the total volume of air needed can be readily worked out, or the manufacturer of compressor and tools will be very glad to assist in determining this second factor.

POWER AVAILABLE.

If steam is at hand a steam-driven compressor of simple, duplex or compound type, depending on the steam pressure and volume of air, generally recommends itself.

With low steam pressure from 75 to 100 lb. and a required volume not exceeding 800 ft., a single air cylinder finds frequent use. This type is not the most economical from the steam standpoint, but is compact, simple in construction and has many desirable features. Above 800 ft., and with the same low steam pressures, the duplex type with the advantage of four power impulses for each revolution is frequently employed. Either duplex or two-stage air cylinders are used with this type. When the steam pressure is above 100 lb., compound cylinders should generally be employed, and especially if the steam pressure is much above 100 lb.

For the larger sizes, from 1000 cu. ft. up, compound steam cylinders are almost essential and also two-stage air cylinders. Larger units, of 2000 ft. and upward, should be of the Corliss type, their greater first cost being soon offset by the considerable saving effected by their low steam consumption.

It is also well, when the volume of air to be supplied is large, to install two units, each having a capacity equal to light working demands or both together having a combined capacity equal to maximum demand and also some reserve for growth.

BELT OR ELECTRIC DRIVE.

In many shops where shafting is running near the location selected for the compressor, and surplus power is available, a belt-driven machine forms the most satisfactory type. For belt-driven, except in the smaller sizes, the duplex—that is, two cylinders side by side, driven from one shaft having a pulley at the center—is the most desirable form, as it gives four compressions per revolution, thus producing a more even belt load. In every instance where electricity is available a belt compressor can be driven from a suitable motor. This arrangement is advantageous, in that it permits starting or stopping at will, without the intervention of idle pulleys, clutches or other power-absorbing devices.

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*Condensed from a paper by Thomas Aldcorn, before the American Boiler Manufacturers' Association, New Orleans, March, 1912.

Latterly motor-driven compressors are in considerable demand, either geared or, in the case of larger units, with motor mounted directly on the compressor shaft. For the smaller sizes an automatic starting controller and pressure regulator can be furnished if desired, and this will maintain practically a constant pressure, shutting down the motor when the desired limit is reached, or starting up where the pressure falls, due to an increased demand for air. Still another method of driving in larger units is to mount the motor armature or rotor directly on the compressor shaft. an arrangement somewhat like a direct-driven generator outfit. The power is applied directly to the shaft, and all belts, gears and other parts are unnecessary.

INLET CONDITIONS.

In piping up the compressor it is well, if possible, to take the inlet air from the shady side of the building or from outside the engine room, where cool air can be obtained, as each 5 deg. reduction in initial temperature will effect a saving of 1 per cent. in the operation of the compressor, or intake air 25 deg. colder will increase the capacity of the compressor 5 per cent. It is also well to make the inlet of good size and as short and direct as possible, to reduce inlet friction to a minimum.

Often, and always if in a dusy or sooty location, it is advisable to put a strainer on the exposed end of the inlet pipe or box. Such a strainer can be readily made by covering one side of a substantial box with wire netting and putting outside of this one or two layers of muslin, through which the air must be drawn. While a strainer is not essential under ordinary conditions. in many cases it is, and in nearly all cases strained air will help avoid lubrication troubles and add to the life of valves, piston and glands.

THE AFTERCOOLER.

The compressed air leaves the compressor at a fairly high temperature. averaging about 350 deg. As the amount of invisible moisture which can be held in air depends on its temperature, it is evident that all the moisture taken into the compressor is also discharged therefrom, to condense in the receiver or air mains later on. That this needs consideration is evident when it is recalled that a 500 cu. ft. compressor will draw in through the intake pipe 500×60×10=300,000 cu. ft. of air per day of 10 hours, and on a damp or rainy day this may contain as much as a barrel of water for the day, although the average would be less. For this reason, especially in the larger installations, an efficient aftercooler is most desirable, and it is actually essential if the transmission lines are long or exposed to the outdoors.

The aftercooler is a device arranged to take advantage of the principle mentioned; that is, air will carry a varying amount of moisture, depending on its temperature, or at a given temperature air will hold only a certain amount of moisture, beyond which it becomes saturated and the excess moisture will be precipitated as dew or rain. Hence, if we can reduce the temperature of the air below that at which it will enter the transmission mains, moisture troubles will be very largely eliminated.

Of course, it must be remembered that when the air is actually used or expanded in the exhaust of the pump, engine, drill or other air-driven device the rapid expansion causes a temperature reduction considerably below what can be obtained in the usual water-cooled after-cooler, and there may be some precipitation from the compressed air at the point of application. Usually, however, the moisture noticed around air tools is on the outside and is really the accumulation from the surrounding air, like the moisture on the outside of a glass of ice water.

THE RECEIVER.

From the compressor and aftercooler the air passes to the receiver, which performs a twofold function: First, as an equalizer of the pressure, to receive the rapid pulsations of the compressor's discharge, and, like a spring, or the gas bag on a gas engine, equalize or smooth out the pulsations, thus insuring a steady flow of air to the transmission lines. Second, to contain a stored supply of compressed air, which helps the compressor over any sudden momentary increased demand for air.

There is an erroneous idea current with re-

(Continued on page 6436.)

COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC

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THE ELECTRIFICATION OF THE QUARRY

Perhaps few lines of industry have been more improved in means and methods employed and in results accomplished than has been the cutting of stone from its native bed. This is one of the primitive, as it seems also to be one of the most enduring of man's occupations, coming next perhaps to the hewing of wood and the drawing of water. These two latter, the getting of fuel to keep warm and to cook by and the conveying of water to drink and bathe in, cited originally as the most menial and enslaving of occupations, have been dignified into the life work of the great engineers, and the getting of building and monumental stone is now similarly elevated.

The first cutting of stone could scarcely have been called cutting at all. It was a splitting or tearing away of fragments whose shape and dimensions were largely determined by chance, much as a hungry man might tear away his mouthfuls of bread from a stale and crusty loaf. What we take from the loaf now is carved in regular slices and the loaf itself is respected and left in perfect condition for the next carving, so that it might gladden the heart of a careful housewife to look at it. In the cutting of the stone now there is no wasting of the material, and the pieces got out can be shaped and finished to predetermined dimensions with a minimum of labor.

The stone channeler has been the most active and effective agency in the development of the modern quarry along the lines of precise, systematic and profitable operation, and the sight of a great plant where the channeler dominates cannot but be gratifying to anyone who has any appreciation of the difficulties and the exactions of this line of work.

The stone channeler, while unique in its line of work from the first, has had its long period of development and of approach to the perfection of design and action which is never quite attained. It has grown larger and heavier and more elaborate, but all the while it has been more especially acquiring the knack of doing more and better in its special line.

The channeler has been quite generally steam driven, each having its own boiler as an integral part of it, and being thus self contained and independent of everything except an unfailing supply of fuel and water. The firing of the boiler and the maintenance of the supplies for it have of course entailed much extra cost of operation, a feature most desirable to avoid, and so other channelers have been operated very satisfactorily with compressed air, but here also were a compressor and pipe lines to be provided and the accompanying cost of them.

It must have been a most welcome consummation when the electric air drive and the track channeler got together, for their mutual benefit and for the comfort and profit of all concerned. These are so evidently adapted to each other that it might be said they could not long have been kept apart in any case. The channeler churns along in a livelier way than ever before; does more work and requires less than half the power to do it, and there are no offsetting disadvantages to be compromised with. The electric motor and pulsator apparatus ride upon the machine in the most comfortable way, taking up less room than the displaced boiler.

Most important of all, the coming of the electric air drill, and especially of the electric air channeler, makes it possible to use one system of power transmission for the entire plant. At the present writing the electric equipment is a necessity for lighting, and for power purposes it approaches the ideal. Quarries are quite apt to be located within reach of water powers which can be utilized to drive generators, thus providing the cheapest power known. It is a curious thing that a special compressed air invention, which after all the electric air drive distinctly is, should so help to promote and extend the reach of the electric current.

BARGE CANAL AND PANAMA CANAL

It would seem that the N. Y. State Barge canal, as an engineering work of great magnitude involving many diverse and difficult problems, has not received adequate appreciation. The Barge Canal Bulletin cites as below a number of particulars in which the work may be compared with that of the Panama canal.

The Panama canal is 50 miles in length; the Barge canal, including navigable lakes, 350 miles in length. The estimated cost of the Panama canal is $375,000,000. The estimated cost of the Barge canal is $108,000,000, but these estimates of cost are not indicative of the amount of work being done. On account of the large amount of excavation necessary at the Culebra cut in the Panama canal, the total excavation is much greater than for the Barge canal, being 175,000,000 cubic yards as compared with 110,000,000 cubic yards. Concrete to the amount of 5,000,000 cubic yards will be used in the Panama canal construction, and approximately 3,000,000 cubic yards on Barge canal construction. At Panama the concrete is placed chiefly in the six pairs of locks, while in the Barge canal construction, the number of structures greatly exceeds the small number at Panama. There will be 57 standard locks on the Barge canal and several smaller ones. Thirty dams will be built and several remodeled. The bridges to be constructed will number nearly 200, making the total number of structures to be erected in the Barge canal improvement between 350 and 400. Comparisons are not altogether possible where conditions are variable, but taking into consideration the length of the canal, the number of structures, the alignment through a well developed country and the necessity for maintaining navigation, together with the difficulties encountered through cities in the construction of the Barge canal, the people of the state have some reason for satisfaction in their unaided accomplishment in canal construction.

VENTILATION NEGLECTED IN SINKING SHAFTS

At Thorns Colliery, Yorkshire, England, where shaft sinking operations were being carried on an accident occurred enforcing an important lesson. The shaft was 22 ft. in diameter and had reached a depth of only 120 ft. A round of 15 shots in the bottom of the pit had been fired by an electric battery, each shot containing 1¼ lb. of gelignite. Immediately after the firing of the shot a foreman and laborers descended the pit in a hoisting bucket ("bowk"). On reaching the bottom of the shaft, about five or six minutes after the shot had been fired, the men began to cough, and several of them became very weak and ill.

A second gang of laborers descended and reached the bottom of the shaft about 15 min. after the first gang, and one or two of them also were affected by the fumes. During the shift several of the first gang became so ill that they had to cling to the rings of the shaft; but the significance of the symptoms mentioned was not realized by either the men themselves or those in charge of the work. The men temporarily recovered, with one exception, this man going to the surface an hour before the completion of the shift; the rest worked about three hours after the firing of the charge mentioned above. Then they went home, but during the night several of them became seriously ill, and one died about the middle of the next day (Mar. 17).

All the men who went down in the first bucket, and one at least of those in the second bucket, developed similar symptoms. No mechanical means had been taken to produce a ventilating current in the shaft, and the heat of the steam pipes used therein caused a current of air, which was depended upon to ventilate the workings. The shaft was wet; the amount of water being made being about 120,000 gal. per hour.

The symptoms show that those of the men who were affected by the poisonous fumes of the shot were suffering from the effect of carbon monoxide, and nitrous oxide poisoning. Prominent among these symptoms was a confusion of thought and expression, even when the persons affected thought themselves quite well (pointing to the presence of carbon monoxide), and violent coughing (pointing to nitrous-oxide poisoning). The inferences which may be drawn from this case are that carbon monoxide was responsible for the more immediate symptoms, and the nitrous fumes for the bronchitis.

TUNNEL BUILDING AND SCENERY PRESERVATION

The following extract from a tunnel contract it is needless to say was not written in the United States. It refers to the Arthur Pass tunnel, under construction for the New Zealand Government Railways:

"The works are situated in a national scenic reserve. The contractor shall carry out all his works in such a way as to cause no permanent disfigurements. Workmen or others connected with the works convicted of setting forest or bush or other vegetation on fire will be liable to immediate dismissal and to prosecution. Beyond the formation of the approach cutting at the Bealey end of the tunnel no works of any kind, except such as may form part of this contract, and no cutting of timber will be permitted on the hillsides on the left bank of the Bealey within 40 ch. of the tunnel mouth, both up and down stream. At the Otira end of the tunnel, no timber will be allowed to be cut from the forest for construction purposes, and only firewood from fallen or dead trees will be allowed to be used by the contractors or workmen as permitted by the Resident Engineer. In the Bealey valley, timber may be allowed to be cut in such restricted quantities and in such localities as shall be allowed by the Resident Engineer."

BREATHING

The amount of air breathed in at one normal inhalation of an average male adult is 500 cubic centimeters, or 30.5 cubic inches; but when taking vigorous exercise, seven times as much. The total area of the lung surfaces is about 30 square meters or 323 square feet; that of the body, however, only 2 square meters or 21.53 square feet.

An adult breathes ordinarily in a minute, about 18 times; when doing ordinary physical work, 25 times; when taking vigorous exercise, 60. In case of inflammation of the lungs the respiration takes place at the rate of about 40 breaths a minute. In the nasal passages the air is warmed more rapidly and thoroughly than when it passes into the lungs through the mouth. Air at a temperature of 6 deg. Cent.=42.8 deg. Fah. is raised to 32 deg. Cent.=89.6 deg. Fah. during the short time of an inhalation through the nose. The reason of the more thorough warming by nasal breathing is that the total surface of the nasal passages in the average adult is 100 square centimeters or 15.5 square inches; those of the mouth having an area of only 70 square centimeters or 10.85 square inches.

In Sydney, Australia, recently two workmen were accidentally electrocuted under quite different conditions. One man was a rock-driller working on the sewer outfall works at Long Bay, and his death was caused by the current short-circuiting with a rock-drill which he was handling. The second case was that of a fireman employed at Saxton and Binns' timber yards at Pyrmont. He was carrying a small flexible extension electric hand lamp, when, owing to a short circuit occurring, a current of 2400 volts passed through his body, death being instantaneous.

(*Continued from page* 6432.)

gard to the storage of air, for, without the use of an excessively large receiver it is not possible to store more than a few seconds' or a minute's supply. A receiver 48 in. in diameter and 12 ft. long contains about 153 cu. ft.; when filled with air at 100 lb. pressure it will hold about 1200 cu. ft. of free air. If the compressors supplying were shut down the flow through a 1½-in. main would in a few seconds drop the pressure from 100 lb. to a pressure too low for working purposes. It is therefore evident that, except under peculiar conditions, the storage feature should be ignored and a compressor installed of sufficient capacity to easily take care of immediate and reasonable future requirements.

Frequently it is a good plan to install additional receivers at junction points or elsewhere in the transmission system, to equalize the pressure and to take care of any sudden or excessive local demand. These auxiliary receivers also act as separators to remove from the air additional grit and moisture.

THE TRANSMISSION.

The transmission system of pipes conveying the air from the compressor to the various points of usage should receive most careful attention, both in location and in putting up. Lines should be made of ample proportion and figured with due regard to equivalent areas. They should be run as direct as possible, with few turns or angles, and it will pay in the end if bends or long turn fittings are used. Branches and outlets should be near enough to permit of sufficient tools being operated without the use of long hose lines, usually so that a 50-ft. hose will over-reach another 50ft. hose. Each branch should have a tee and two outlets closed with good, solid globe or gate valves.

The practice of using nothing less than 1-in. pipe for branches is to be recommended. Full-weight pipes, substantial fittings, first-grade valves and care in supporting mains, drops and branches are all essential, for it must be remembered that with air at 100 lb. pressure a 1-16-in. hole will leak the equivalent of a horsepower.

All piping should be carefully inspected, rapped to break loose inside scale, and then blown out. All joints should be made up with lead and screwed up tight, and every precaution taken to make the work permanently airtight. At suitable points drip tanks or separators should be inserted in the mains, these being provided with drip cocks. Drip cocks should also be placed at all low points.

Outlets should all be provided with an approved form of universal quick-acting and locking hose coupling, and the same form should be used through and on all hose for interchangeability.

Only the best grades of hose should be used, wire wound for the longer or leader hose, and a short length of plain tubing for connecting with the leader. All hose should be cared for. It is expensive and deteriorates rapidly, and it has been shown that many troubles charged against the tool have been due entirely to the use of poor grades of hose. The hose should be regarded as part of the tool equipment, and each man to whom hose is issued should be held responsible for its return in good condition.

In every case when getting ready, the valve at the outlet should be opened an instant before connecting the hose. The hose should then be blown out, and then the hose connected to the tool.

PNEUMATIC TOOLS.

First in importance should be mentioned the chipping and riveting hammers. The chipping, calking and bending hammers in six or eight different sizes for every character and weight of work, from the thinnest to the heaviest plates, range in weight from 6 to 16 lb., with strokes from 1 to 5 in., and these striking at from 840 to 3200 per min., with air at 100 lb. pressure, acting on a 1 1-16-in diameter piston. It would seem that no argument is necessary to prove the advantage of these wonderful labor-saving tools over the old hand methods in the hands of even ordinary unskilled help.

Pneumatic chipping is unquestionably many times more powerful and efficient than hand chipping. Further, on account of there being no necessity to "swing a hammer," it is possible to work in out-of-the-way places and corners where hand chipping could only be done with the greatest difficulty. The varying sizes of these tools makes it possible to select a hammer to meet any peculiar set of conditions, and the spring throttle, which is always under the control of the operator, permits an instantaneous adjustment of the blow, from a very light tap to the full power of the hammer, thus enabling intricate chipping to be done quickly. Further, the chipping can be carried on very much closer to the finished size than can possibly be done by hand.

When it is considered that an ordinary operator can take a ⅜-in. chip off a ½-in. plate at the rate of 8 in. per min., and this is compared with the time and work which would be required to cut the same chip by hand, some slight idea of the advantage of pneumatic chipping can be gained. It is a conservative statement to say that one man with a pneuamtic chipping hammer can do from three to five times as much as he could do by hand.

For calking, the pneumatic hammer is ideal; for, by selecting the proper weight of hammer or throttling the air pressure so as to limit the force of the blow, the metal can be condensed and calked with an evenness impossible with hand methods, and the depth of the compacting of the metal can be regulated to suit conditions. In addition to the plate chipping and calking, in most boiler shops there are usually iron or steel castings, all sorts of brackets and supports, stack bases and other parts in and around the boiler or boiler settings, all of which need a certain amount of dressing.

FEATURES OF THE PNEUMATIC RIVETING HAMMER.

The penumatic riveting hammer of the long-stroke type, weighing from 14 to 21 lb., depending on the class of work for which it is intended, and having from 840 to 1080 blows per min., is a marvelous device, and even in the hands of an inefficient operator does so much more work and does it so much better than could be possibly done by hand that it is inconceivable that any one would tolerate hand riveting of any sort.

It is not safe to heat a steel rivet beyond a certain point if its fibrous texture is to be retained and the full strength of the rivet made available. If the rivet is driven by hand it will be seen that, no matter how rapidly the riveters strike, they cannot possibly upset and heat the rivet as quickly as it can be done by a machine which strikes a more powerful blow, probably 10 to 20 times faster than any riveter can possibly strike. On this account the rivet fills the hole and is headed before it is cooled to any great extent, and as it cools and is followed up by the riveter, the plates are clamped together tighter than is the case with a hand-driven rivet. Besides, there is less likelihood of the rivet running over and heading up off the center.

It is impossible to imagine any form of working machine simpler in construction than a riveting hammer, consisting as it does of the barrel, valve box and valve, handle and trigger, and while we sometimes hear complaint as to the cost of repairs, such cost is trifling compared with the results obtained. In fact, we do not believe it an exaggeration to say that any good shop has its capacity doubled or tripled by the introduction of pneumatic chippers, riveters and drills.

OTHER DEVICES FOR WORKING ON RIVETS.

Along with pneumatic hammers come, of course, pneumatic holders-on for backing up the rivets; jam riveters for working in restricted places or in flues and other positions where the ordinary riveter cannot be operated; rippers for cutting up tanks, boilers and other plate work; rivet busters for flogging off the heads of rivets and stay bolts, for purposes of repair or absolute dismantling of boilers and tanks, and other special devices of kindred sort, many of which are specially made, having been developed in some particular shop.

Pneumatic compression riveters, either portable or stationary, and yoke riveters of varying design are largely used where the character of work demands this type. When properly mounted so as to be flexible they constitute a very important addition to any boiler shop equipment. In principle the compression riveter is much the same as the ordinary hydraulic riveter, except that the riveting plunger is advanced by means of a toggle or an arrangement of levers in turn moved by a piston moving in a compressed air cylinder.

PNEUMATIC DRILLS.

Pneumatic drills—that is rotating drills for metal drilling—are made in various sizes, ranging from the smallest, generally for wood boring, up to the powerful compound gear type having a capacity to drill up to 3 or 4 in. in metal and weighing up to 118 lb. In principle they consist of a multiple cylinder air-actuated engine, driving a crankshaft which is geared to the drill spindle or socket which takes the drill. On the smaller sizes the spindle speed is as high as 2600 rpm., whereas in the larger compound types the spindle speed is as low as 36 rpm.

The power of these drills varies, of course, with the air pressure, but it is astonishing to see how rapidly they work and what enormous power they have. Their absolute flexibility lends them to all classes of work, and for general drilling, reaming, tapping, flue rolling or cutting out flues from old boilers, there is nothing which compares with them. Through their use it has been possible to introduce methods of construction in boiler shops which have worked a revolution in the cost of boilers.

In connection with railroad locomotive boilers, rules have been formulated which require the drilling of tell-tale holes in staybolts, and the small size pneumatic drills are the most desirable tools for this work or for cleaning out these holes as occasion requires.

Scaling tools for removing the scale from the inside of boilers are nothing more than small, light pneumatic tools striking a fairly light blow but having a very high speed and they can accomplish an enormous amount of work in a most satisfactory manner.

PNEUMATIC HOISTS, CRANES AND JACKS.

Pneumatic hoists and pneumatic geared cranes are largely used in boiler shops for convenience in handling the various parts entering into the construction of boilers in the different stages of their construction from machine to machine, and where air is available a considerable saving in labor can be effected through the use of these devices. The pneumatic cylinder hoist is a direct-lift type and can be furnished in capacities up to 20 tons and for any reasonable lift. Where this type cannot be used, the geared hoist is easily mounted on a hook and swung from a jib crane or may be arranged to travel on the under flanges of an I-beam trolley track. These can be obtained in standard sizes from 1 to 10 tons. They consist of suitable air motor and necessary gearing, together with a drum, all contained in a sturdy frame and suspended from hook or trolley wheels, as the case may be. They are a most desirable adjunct to any boiler shop, and with reasonable care have a long life and make a good showing in every way.

Pneumatic painting or paint sprayers may though not so great as some of the other devices mentioned. In principle they consist of a cylinder with a piston; a heavy piston rod projecting through the top head of the cylinder, the air being admitted to the bottom, the

Pneumatic jacks also have a useful field, alpiston moves upward exactly as in the case of a hydraulic jack. These can be obtained in stock sizes from 1 to 20 tons and prove themselves a very useful tool, either for permanent installation in some fixed place as an adjunct to a permanent machine or mounted on wheels for ready movement.

MISCELLANEOUS AIR APPARATUS.

Pneumatic forges for rivet heating or tool tempering are light and compact, hence readily transferable, and can be taken close up to where the work is being done, thus insuring hot rivets without burning. They are simple in construction, durable and very efficient, and eliminate any necessity for pumping or grinding a rivet forge.

Pneumatic grinders of several sorts can be obtained, and these are very desirable for finishing edges of plates, corners or for any other special grinding where it is desirable to take the tool to the work. They consist of a standard form of air motor, practically the same as that used in the pneumatic drills, with a suitable extension shaft for mounting on wheels which are made for either face grinding or edge grinding.
be used to considerable advantage in and around a boiler shop for painting boilers, tubes, etc., before shipment. In the hands of even an inexperienced operator they do rapid, economical and satisfactory work.

This review of a most comprehensive subject is incomplete, as a paper much longer than the present one could be written on any one of the tools mentioned. However, it is hoped that interest has been aroused and that discussion will be provoked which will bring out special uses and devices that our various members may have found helpful in connection with their own practice.

AN EARLY SAFETY VALVE LESSON

The following seems to have come over to us from the eighteenth century. The "steelyard" spoken of is of course the safety valve lever.

"When the weight was at the farther end of the steelyard, the force of the steam, being then very strong, would lift it up, and the steam would go out at the valve rather than spoil the boiler. A man who knew naught of the nature of the boiler set about to run it, and thinking to make his work done the quicker, hung a heavy plumber's iron upon the end of the steelyard, the weight itself being in like manner at the very end. The result proved fatal; for the strength of the steam collected until its force rent the boiler with a mighty explosion, and killed the poor man by the pieces which flew asunder."

NOTES

Mr. W. L. Saunders, editor of COMPRESSED AIR MAGAZINE, will deliver the commencement address at the Colorado School of Mines, Golden, Colo.

The Peerless Air Check Valve, described in our April issue, is manufactured by the Trolley Supply Company, Canton, Ohio.

The amount of steam power used in this country is estimated at 27,000,000 horsepower. Of water power, 35,000,000 horsepower are said to be available, but only 5,000,000 has been developed.

The first annual national gas engine show, to include everything in gas power and allied lines, will be held in Milwaukee, June 17 to 22, inclusive, in connection with the convention of the National Gas Engine Association.

In the article "Tests of Turbo Compressors," page 6400, of our April issue, a 4000-hp. compressor at Johannesburg was described as having a "capacity of 1,250,000 cu. ft. of free air per minute" and an "energy consumption per 100 cu. ft. of free air of 0.301 hp." Comparison of other figures in the article shows that these statements should have read "1.250,000 cu. ft. of free air per hour" and "0.301 hp.-hr." respectively. Also an air pressure of 114 lb. was made to read 114,000 lb.

The first week of August has been fixed for the celebration of the centenary of the great Krupp works at Essen, Germany, which will be attended by the Kaiser at the head of a brilliant galaxy of his fellow-German sovereigns, generals, admirals and civic dignitaries. The Krupps have also decided to invite distinguished representatives of the steel and iron industry in all parts of the world, including several from the United States. A feature of the festivities will be a series of sham battles. Men armed with weapons of the era of the Emperor Maximilian I will make such headway as they can against an army equipped with modern rifles and artillery.

Recently mercury ores were discovered by a peculiar accident near Field, British Columbia. The manager of the Canadian Pacific Railroad hotel at Field found mercury in the hotel sink. At first it was supposed some one had broken a thermometer, but the event recurred, and finally an examination showed native mercury in the gravels of the stream supplying the hotel with water.

A great blast at Tenino, Wash., was made up of 45,000 pounds of black powder and 1,200 pounds of dynamite. The blast dislodged about one million tons of sandstone, which will be used on the government jetty at Gray's Harbor. The explosive was placed in two tunnels 150 and 186 feet deep and seven laterals of 50 feet each. It was fired by a battery 1,500 feet distant.

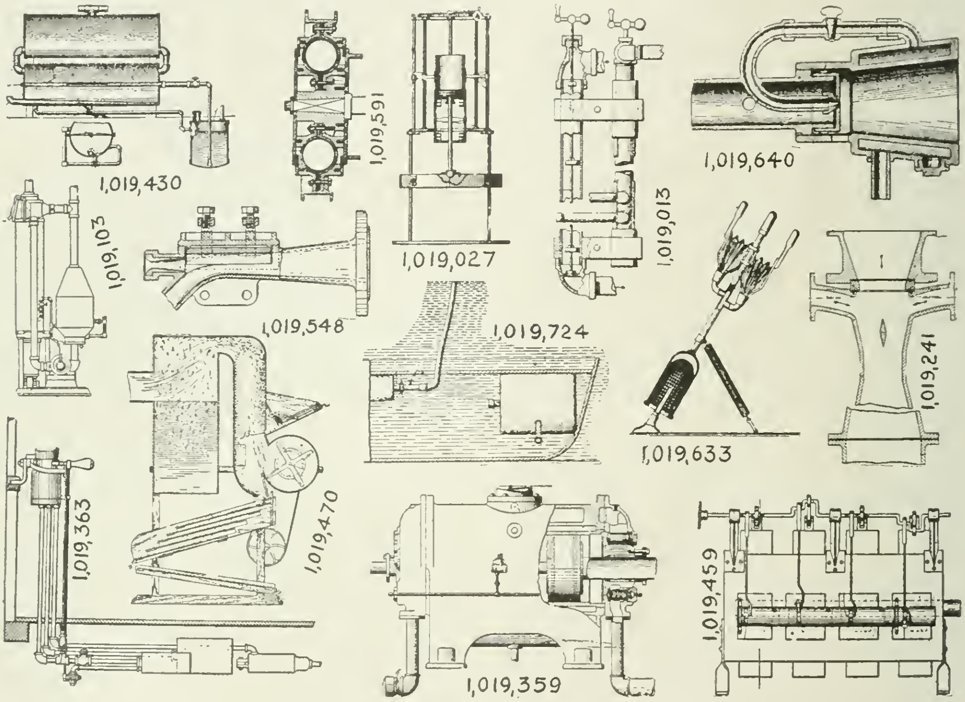
An average man of 150 pounds contains the constituents found in 1,200 eggs. There is enough gas in him to fill a gasometer of 3,649 cubic feet. He contains enough iron to make four ten-penny nails. His fat would make 75 candles and a good-sized cake of soap. His phosphate content would make 8,064 boxes of matches. There is enough hydrogen in him in combination to fill a balloon and carry him above the clouds. The remaining constituents of a man would yield, if utilized, six teaspoonfuls of salt, a bowl of sugar, and ten gallons of water.

The barbers in the cities of the Calumet region are having an experience of their own with Portland cement. They find that employees of the cement plants in these districts have concrete faces. The barbers claim that in the plants the cement dust settles in the men's beards, perspiration moistens it, and when they go out into the open air, it sets and faces are covered with concrete, reinforced by stiff whiskers. This takes the edge off the razors. Steps are being taken to invent a tonsorial sand blast.

Two shotfirers were recently saved at Radley, Kan., by means of a mine-telephone system. When the shotfirers were at work one evening, in the mines of the Girard Coal Co., an explosion occurred. The engineer at the surface, to whom the shotfirers reported from station to station as the blasts were set off, was able to direct the rescue party to the approximate location of the shotfirers, who were quickly taken out and resuscitated. This mine-telephone system thus not only saved the lives of these men, but from a purely business point of view, more than paid for itself in the elimination of damages that would probably have occurred in the event of these men not being rescued.

In Switzerland, water power is conserved and utilized to such an extent that in some towns not an ounce of coal is used. Power, light and heat are furnished by water power.

Every known explosive, if fired in a sufficiently large charge, will cause the ignition of an explosive gas mixture, but explosives have been found to differ widely in regard to the amount that can be fired without causing such ignition. Ordinary black blasting powder, for example, will cause the ignition of explosive gas mixtures very readily, as little as 25 gm. (somewhat less than an ounce) invariably serving to bring about this result. Certain other explosives, in quantities as great as 1000 gm. (2⅕ lb.), after repeated trials, under conditions exactly similar to those used in testing black powder, have invariably failed to cause ignition of the explosive gas mixtures.



Pneumatic Patents, March 5.

LATEST U. S. PATENTS

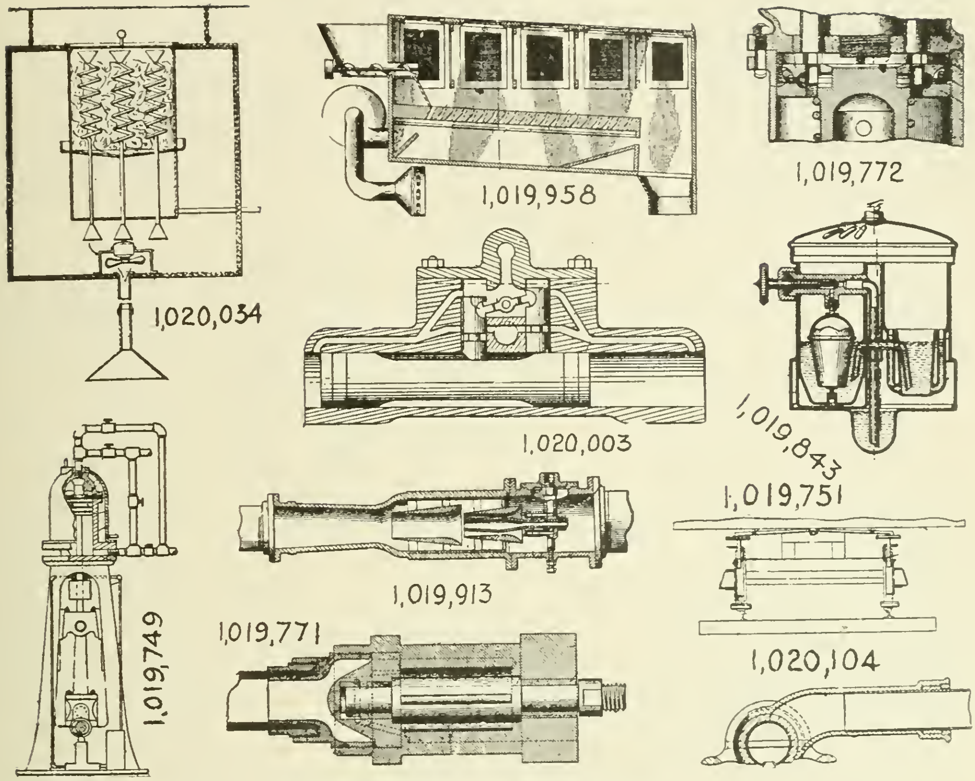
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 5.

1,019,013. BLOWER AND SHOWER FOR PAPER-MACHINES. Otto Baker, Piermont, N. Y., and Eugene J. McCarty, Clinton, Mass.

1,019,027. WAVE-MOTOR. John William Denny, Mapimi, Mexico.

1. In a wave motor, the combination with a supporting frame, of a compression cylinder supported by the frame, a piston in the cylinder having a depending piston rod, a float secured to the latter end of the piston rod, the undulations of the waves shifting the float and thus the piston to compress air in the piston, a frame secured to and depending from the cylinder, said



PNEUMATIC PATENTS, MARCH 12.

frame having a portion providing a guide for the piston rod, an abutment bar secured on the piston rod and lying within the frame, and resilient abutments carried by the cylinder and by the frame for engaging said bar to limit the movement of the bar and thus the piston in either direction.

1,019,103. LUBRICATING SYSTEM AND APPARATUS. FRANK W. VAN NESS, Milwaukee, Wis.

1. The combination with a vacuum system of a pump for creating a vacuum therein, an oil supply chamber the upper part of which is in communication with the vacuum system, and an oil reservoir which is in communication with said oil supply chamber and in which reservoir the oil is subjected to a greater pressure than the pressure which exists in the vacuum system when the pump is in operation.

1,019,135. PNEUMATIC FLOOR - OILER. CHARLES W. COREY, Malden, Mass.

1,019,241. HYDRAULIC APPARATUS FOR EXHAUSTING OR EXTRACTING AIR, GAS, OR VAPOR. WILLIAM JOHNSTON FRAME, Glasgow, Scotland.

1,019,359-60. UNLOADER FOR FLUID-COMPRESSORS. WILLIAM PRELLWITZ, Easton, Pa.

1,019,361. MOUNTING FOR AIR - FEED DRILLS. WILLIAM PRELLWITZ, Easton, Pa.

1,019,363. RAILWAY PNEUMATIC APPARATUS. JAMES R. RICKETTS, Los Angeles, Cal.

1. In railway pneumatic apparatus, a compressed air supply, a container for partially spent compressed air, a controller for directing compressed air from the compressed air supply to brake actuating mechanism and for directing partially spent compressed air from such brake actuating mechanism to said container, and means for passing partially spent air to the open atmosphere at a point between said controller and said container; said last named means being actuated by the handle member of the controller.

1,019,430. METHOD OF CARBURETING AIR. ROBERT C. DAWSON, McKeesport, Pa.

1,019,459. AIR-MOTOR. IRA L. GRINNELL, Detroit, Mich.

1,019,470. GRAIN-CLEANER. THOMAS O. HELGERSON, Minneapolis, Minn.

1,019,499. POSITIVE-PRESSURE BLOWER. HOWARD S. LEVY and GORDON H. BRANDES, Philadelphia, Pa.

1,019,548. SUCTION DEVICE FOR DUST-LADEN AIR. KARL SPITZER, Vienna, Austria-Hungary.

1,019,591. PNEUMATIC HUB. CHARLES EDWARD DE BOOS, Temora, New South Wales, Australia.

1,019,633. VACUUM-CLEANER. MICHAEL D. HADJISPIRIDIS, New York, N. Y.

1,019,640. OIL-BURNER. LEO MICHAEL HENNESSY, Providence, R. I.

1,019,724. DEVICE FOR RAISING SUNKEN BODIES. JOSEPH POLIZZI and FRANCIS WARREN CALONGNE, New Orleans, La.

MARCH 12.

1,019,749. COMPRESSOR. JOHN B. BENDER, Toledo, Ohio.

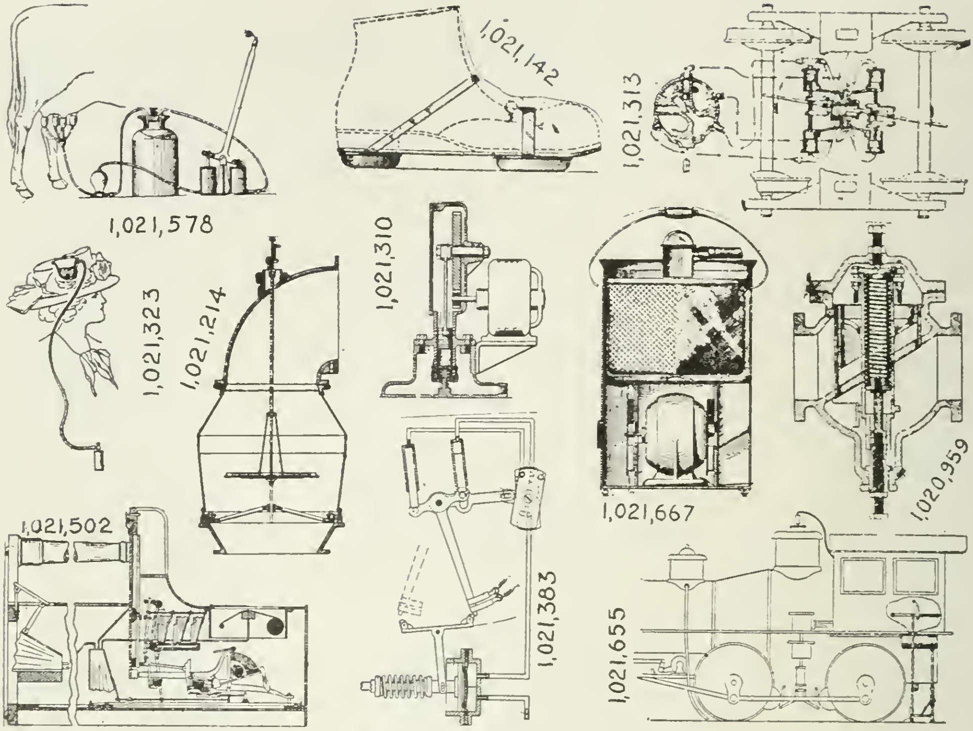
1,019,751. DERAILMENT AIR-BRAKE. EUGENE N. BOTSFORD, Platteville, Wis.

1,019,771. ROTARY MOTOR. WILLIAM S. ELLIOTT, EDWARD R. MILLS, and HARRIS B. HOLT, Pittsburgh, Pa.

1,019,772. METHOD OF LUBRICATING PNEUMATIC MACHINERY. EDWIN A. EMERY, Cripple Creek, Colo.

1,019,787. MOUTHPIECE FOR OZONE-MACHINES. ROBERT P. GUILEY, Akron, Ohio.

1,019,842-3. AIR-MOISTENING DEVICE FOR



Pneumatic Patents, March 26.

HEATING APPARATUS. William A. Russell, Waterbury, Conn.

1,019,818. VENTILATING APPARATUS. Francis Joseph McMurdie, Detroit, Mich.

1,019,913. PRESSURE-TRANSFORMER. William H. Pearce, Chicago, Ill.

1,019,958-9. SUGAR-DRIER. William H. Hannam and Warren E. Murray, San Francisco, Cal.

1,020,003. VALVE MECHANISM. James Edward Williams, Bessemer, Ala.

1,020,034. AIR-COOLING APPARATUS. Felix Frank, Cleveland, Ohio.

1,020,102-3. PROCESS FOR SEPARATION OF HYDROGEN FROM GASEOUS MIXTURES. Carl von Linde, Munich, Germany.

1,020,104. VACUUM-SWEEPER. Frank J. Matchette, Milwaukee, Wis.

1,020,241. PUMP FOR VACUUM-CLEANERS. Charles G. Wiborg, Galesburg, Ill.

1,020,310. VACUUM-CLEANER. William H. Rakestraw, Bloomington, Ill.

13,384. (Reissue.) PNEUMATIC APPARATUS. Joseph Schwertner, New York, N. Y.

MARCH 19.

1,020,619. VALVE MECHANISM FOR PNEUMATIC TOOLS. Vincent J. O'Brien and Romeo C. Awkerman, Denver, Colo.

1,020,852. APPARATUS FOR COMPRESSING AIR AND OTHER FLUIDS. Walter B. Swindell, Raleigh, N. C.

1,020,859. WHISTLING-MACHINE. Edward Vanderali and Joseph Litmer, Adrian, Minn.

1,020,893. SOLID LUBRICATING COMPOUND FOR COMPRESSED-AIR APPARATUS. Edwin A. Emery, Denver, Colo.

1. A solid lubricant having a moisture soluble surface and adapted to be transported to pneumatic machinery by air currents containing moisture, comprising moisture soluble solid soap, glycerin in quantity to render the product non-refrigerant and non-drying, lubricating oil to render said product resisting to penetration of moisture and a powdered mineral lubricant for the purpose specified.

MARCH 26.

1,020,959. PRESSURE-REDUCING VALVE. Edwin J. Best, Ensley, Ala.

1,021,142. PNEUMATIC WALKING ATTACHMENT. Malcolm W. Freeman, Millington, Mass.

1,021,214. GOVERNOR FOR AIR-COMPRESSORS. Richard H. Rice, Lynn, Mass.

1,021,310. AIR-PUMP. Herbert J. Hawthorne, Guy B. Wyatt, and Otto P. Warner, Cleveland, Ohio.

1,021,313. RAILWAY-SWITCH CONTROLLER. Philip D. Hibner, Seattle, Wash.

1,021,323. BUBBLE-HAT. Alden L. McMurtry, Sound Beach, Conn.

1,021,383. PRESSURE-REGULATOR. Martin V. Smith, Hartford, Conn.

1,021,502. PNEUMATIC PIANO. William G. Betz, Chicago Heights, Ill.

1,021,578. MILKING-MACHINE. Leo D. De Laney and Mathias A. Holtzbauer, Belmond, Iowa.

1,021,655. APPARATUS FOR BLOWING SAND FROM RAILWAY-TRACKS. Charles D. Brown, Washington, Ill.

1,021,667. VACUUM-CLEANER. John J. Duffie, San Francisco, Cal.

1,021,700. PROCESS OF INCREASING THE RAISING POWER OF DRIED YEAST. Peter Diedrich Hinrich Ohlhaver, Sande, Germany.

4. The herein described process of increasing the raising power of dried yeast, which consists in exposing such yeast to the action of air artificially saturated with moisture for sufficient time to cause re-hydration of the dried yeast organisms.

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COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

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AIR TO KEEP THE WATER OUT

By Frank Richards.

In the shock of the appalling and unparalleled Titanic disaster it is difficult for us at the moment to maintain undisturbed our fixed conviction that the safety of ocean travel increases with the years; but if we stop to reason a little, and especially if we compare, decade by decade, the numbers carried with the numbers of the fatalities which occur, we are at once reassured.

The catastrophes of the seas in these later years may individually cause greater losses of life than ever before recorded, simply because greater numbers are carried at once, but happily they are somewhat less frequent, and each becomes at once an object lesson and a warning, is seriously investigated and studied as to cause and prevention, with results which count for greater safety.

The matter most prominent in current discussions of the Titanic is that of providing life boats and other means for keeping passengers and crew afloat when a ship sinks with short warning. It would seem to be scarcely practicable to carry boats or rafts enough for all who crowd a modern leviathan, even when the sea is calm, and this means of saving life dwindles to the infinitesimal when a fierce storm is raging.

By far the most important and promising line to follow is that which leads to consideration of the precautions and devices for keeping the ship afloat, when in sudden danger of sinking from the inrush of water through rents below the water line. Nowhere else is it more true than here that prevention is better than cure. Make ships unsinkable and the fiercest terror of the sea is annihilated.

The unsinkable ship is not yet, although many in recent years, down to the victims of the Titanic, have confidently thought it attained. The "collision" bulkhead, as it was first called, has saved many a ship, but it did not save the Titanic. It is now a feature of all modern ships. In the days of the wooden ship it was not easily practicable, if indeed it was possible, and so we have long lists of ships sunk like the Arctic with often a loss of all or nearly all on board.

That the bulkhead has actually saved many ships is matter of record. Typical local examples, as we might call them, we carry in our memory. There was the Arizona in 1879, the "Greyhound of the Atlantic" of that period; she struck an iceberg in November, not the iceberg season; her first bulkhead held and she was safe. Then a few years after the City of Berlin had a very similar mishap—if you call it a mishap—of ramming an iceberg in the season of ice. Her bow was smashed into a shapeless mass, as the writer remembers the sight of it, but her forward bulkhead saved her. In 1889 the City of Paris had a novel accident, her engine having punched a hole through the bottom, and she was saved by her after bulkhead. When her engine room was flooded and the ship was pitching, and the water was swashing back and forth, there was an anxious time of watching and questioning as to whether the life barrier would hold, and only after this had been hastily but effectually braced by timber on the other side was the anxiety relieved.

Bulkheads have not always held in times of great stress, and disaster has resulted. It is the practice to fill the sections successively with water to see that they are watertight before the ship is launched, but this gives no sufficient assurance of strength, and it is not so easy to devise a test which should satisify.

While the collision bulkhead is one of the simplest of devices as to function, not a thing apparently which any engineer should need to study over except as to strength required and other details of construction, still it is a fact that even this simple thing has been misapplied, and it may also be made to appear that the application of it which might be most valuable of all has not yet been made.

Of the unwisdom of great engineers over a very simple thing there is the episode of the longitudinal bulkhead in evidence. We can see now easily enough how the longitudinal bulkhead works. If a rent is made in the side of a ship provided with a central longitudinal bulkhead, and if one side of the ship, or even a not very large portion of one side, fills with water while the other side is not filled the ship of course rolls over. Yet the British Admiralty had to lose at least two great ironclads, the Captain and the Victoria—or was it the Camperdown?—with a loss in those two of perhaps as many men as went down with the Titanic, before this was realized.

The bulkheads upon which we rely so much for the saving of our ships from sinking—when they save them—are watertight transverse partitions which divide the interior of the hull into sections with the result that if any one, or any two, or sometimes if any three of these sections fill with water as the result of a collision, or the striking of a rock or an iceberg, the ship will still keep afloat. It is understood by the writer that in the Titanic there were fifteen of these bulkheads, or 16 separated sections. Any two adjacent bulkheads exercise their saving function not at all upon the section which they enclose between them but on the section adjoining this one on either side. The enclosed section may fill as it will and the bulkheads offer not the slightest hint of opposition. Yet why not?

Indeed, to protect the section which any two bulkheads jointly enclose should be their most important and imperative service. If each section besides its two water tight, or, for our present purpose, airtight bulkheads, had also an airtight deck enclosing it above, with airtight hatches or doors, and if absolutely nothing more were done or provided, then if a hole however big were stove into or near the bottom so that the water would rush in the section *could not be more than half filled* with water. The air which normally filled the section at a pressure of one atmosphere could pressure, as long as the ship floated, not expressure as long as the ship floated, not exceeding two atmospheres, or 15 lb. to the square inch by a presure gage, and to a volume not less than one-half of what it was originally, and there the water would have to stop.

If now compressed air were forced into that half-filled section at the pressure required, not exceeding 15 lb. gage, the water would all be driven down and out, that is down to the top of the hole by which the water had been rushing in, and to then hold the water from again rising above that level it would only be necessary to maintain the air pressure by forcing in just enough air to make up for whatever air leakage might occur. It would not be necessary to wait for the water to rise in the section before beginning to force in the air. This should be begun as soon as the water began to rush in, or as soon thereafter as possible. No care would be required about the air except to supply it in sufficient quantity. Any excess of air would be driven out at the bottom with the water and no increase of pressure could be thrown back upon the compressor. This is how the air is disposed of when men are working in foundation caissons. The air must be continuously renewed so that it may continue breathable, but it is only necessary to continue forcing the air in; its discharge will take care of itself.

Any compartment of the Titanic between two bulkheads and beneath the lower deck may be assumed to have had a cubical content something like this: 90 ft., abeam; 50 ft., fore and aft; 30 ft., deep=135,000 cubic feet. A considerable portion of this space would be occupied by coal or cargo, so that we may assume a space of 100,000 cu. ft. to be filled, or, in addition to the normal atmospheric content of the compartment, there would be an equal additional volume of air to be supplied, and with air compressors having a free air capacity of 5,000 cu. ft. per min., the space would be filled and the water would be expelled in 20 minutes, and the maximum power required, would be 250 horse power. It is not necessary here to go into the practical details of the arrangement suggested, but it would be well to have oil-engine-driven compressors, which can be started at a minute's notice, located upon an upper deck, preferably one at each end of the ship and connected to deliver into the same pipe system, with all necessary valves, etc.

It would seem to be a somewhat strange and unaccountable thing that there could at this day exist an opportunity for the writer, or for any one else, to be calling attention to this matter. There is nothing in the way of originality of invention in the suggestion, no special ingenuity is required in the application of it, and there can be no question as to the results which would be secured.

It is only applying in anticipation, and for the purpose of preventing the sinking of a ship, what Arbuckle, and, by the way, what others before him, used for the raising of ships, with the advantage that the one who chooses this means among others for making ships unsinkable has a much more complete choice and control of the conditions essential to success than has the man who tries to raise them from the deep.

If even now the providing of water tight bulkheads is made compulsory under the law, and very properly so (although it should provide more adequately for having them strong and stiff enough) it would seem that the providing of airtight decks and hatches, so that any section may be made a pressure chamber and water-excluding, should be equally so.

Although this suggested arrangement promises really an additional element of safety greater than that contributed by the watertight bulkhead itself when not assisted by the compressed air feature, it entails little additional expense. The deck must be there in any case, and such decks even now are practically airtight. Some attention should be given to the bracing or strengthening of them to withstand the upward pressure, and there would be the providing of the airtight hatches, and in some cases double doors or airlocks would be needed, and that is all. The latter suggestion recognizes the fact that it would be easily possible for men to work in the air thus employed to hold the water back, for making repairs or stopping leaks from the inside, for passing up supplies, etc., the pressure being much less than that in which men work in sinking foundation caissons or in driving subaqueous tunnels.

Thus far our thought has been of ships in general, with the passenger ship most prominent; but ships of war are really most ready of all, and also most in need of the application. They have the bulkheads and they have the decks with few and small openings through them, all of which may easily be provided with means of prompt and ready closure, and then all that is needed is the air compressor.

In connection with warships especially it is proper to mention another service which compressed air might render in some emergencies. By the controlling of the air pressure in the different sections and a proper manipulation of the bulkhead doors masses of water might be easily directed from one section to another for the purpose of keeping the ship on an even keel, thus serving to prevent or defer the settling by the head which usually hastens, if it be not the actual cause of a final catastrophe.

THE UNSINKABLE SHIP.

The unsinkable ship is unthinkable without the aid of air, and in the large and general application it need not be compressed air. A familiar incident in the old-time stories of the sinking of ships, the incident apparently necessary to the consummation of the sinking, was the final blowing up of the decks by the pressure of the air confined in portions of the ship. There has been through all these years this standing hint of how to make our ships unsinkable, but nothing has been done to take advantage of it, although the design and construction of our modern passenger ships would seem to have progressed far toward a realization of the ideal of marine safety by providing the possibility of it.

Let us see what we would have to do to make, for instance, such a ship as the Titanic unsinkable provided that she were not ruptured above the water line. The sides of the vessel being watertight up to the fifth or sixth deck, as in the published midship transverse section, and strong enough to resist the wave action outside, are of course, also air tight and of ample strength for our purpose and it is only necessary to give our attention to the deck. Ignoring now the funnels and the big stairways for the passengers, if we had a complete air tight deck here from stern to stern, with all openings in it closed or closable, it could easily be made strong enough to resist the upward pressure of the air by a sufficient number of vertical tie rods equitably distributed and extending to the decks below and to the ship's bottom. No matter how much the ship's bottom might be punctured or torn away the atmospheric air punctured or torn away, the atmospheric air water to keep the ship afloat.

This arrangement, without compressed air to drive back the water, would not keep a warship of the modern type afloat on account of the low freeboard and the smaller air space available.

With the Diesel engine (which seems to be coming) for motive power, all below the deck, it would be possible to have the entire ship for available air space, although when the emergency arose to demand the space the engine must stop running at once.

If the occasion arose for the sudden closing of the deck openings the passengers and others could be passed to the decks above by the air locks provided, and these also would be available for the transfer of whatever material or supplies might be necessary. Air compressors on the upper decks would send air into the space below, first to make up for air leakages and then to slowly drive the water down.

It is understood that this would be a more or less desperate emergency arrangement, but, when in touch with the wireless salvation, is a matter of a few hours only and here the time might be provided.

AMENDED COMPRESSED AIR LAW

We condense here the essential features of the recently amended N. Y. State labor law as related to the use of compressed air in caissons, tunnels and other works.

Hours of labor: In working in compressed air where the pressure does not exceed 28 lbs. to the square inch no employee shall work or remain therein more than 8 hours in any 24 hours and during the period he shall return to the open air for at least 30 consecutive minutes, which interval his employer shall provide for. For pressures between 28 and 36 lbs. the time limit is 6 hours, divided into two 3 hour periods with at least one hour between them. For pressures between 36 and 42 lbs. the permitted time is 4 hours in two periods of 2 hours each with at least 2 hours between. Between 42 and 46 lbs. the total time permitted is 3 hours in two periods with at least 3 hours between them. Between 46 and 50 lbs., which latter is the limit *except in case of emergency*, two periods of 1 hour each will be permitted with not less than 4 hours between them.

Decompression: Any person working in compressed air must pass through an intermediate lock or stage of decompression, which decompression shall be in tunnel work at the rate of 3 pounds every 2 minutes unless the pressure is over 36 lbs., when the decompression shall be at the rate of 1 lb. per minute.

For caisson work the regulations are somewhat different.

Where the pressure is not over 10 lb. the time of decompression shall be 1 minute; 15 lb., 2 min.; 20 lb., 5 min.; 25 lb., 10 min.; 30 lb., 12 min.; 36 lb., 15 min.; 40 lb., 20 min.; 50 lb., 25 min.

In caisson and tunnel work where men are employed in compressed air there must be a medical officer in attendance at all necessary times to enforce the following regulations:

No person shall work in compressed air until he has been examined and found to be qualified, physically, to engage in such work. If absent ten consecutive days he must be examined again. No person addicted to the excessive use of intoxicants shall be permitted to work in compressed air. A beginner in compressed air work shall work only one-half of a day period on the first day and before resuming work must be examined again. After a period of three months of work there must be a thorough examination. A complete record of all examinations must be kept.

Properly heated, lighted and ventilated dressing rooms must be provided, with baths and hot and cold water service, open and accessible to the men between the shifts.

A medical lock is to be maintained, kept properly lighted, heated and ventilated with proper medical and surgical equipment and in charge of a certified nurse.

All tunnels and caissons shall have at least two air pipes or lines connected at all times and in perfect working condition.

Wherever electricity is used for lighting, the light supplied for the shaft leading to the tunnel or caisson shall be supplied from a different wire from the lights which are located at the point where the men are actually working under air.

This act goes into effect Sept. 1, 1912.

BIGGER THINGS THAN A TARIFF AS AFFECTING COST AND EFFICIENCY

BY W. L. SAUNDERS.

In mechanical lines, at least, there are much bigger things than a tariff as affecting the question of whether or not to put capital into an enterprise. To be protected by a tariff or by a bonus or subsidy, or any other form of national support, is an industrial cradle, the main reason for which is to encourage new enterprises. Too great a dependence upon protection, and too long a life under it, are very apt to have a deteriorating effect upon an industry, for whatever may be said, and a good deal can be said, about the destructive results of competition, it remains true that through individual effort, stimulated by competition, the highest efficiency results are obtained.

There is much more in the word competition than destructive cutting of prices. The thing that sells cheapest is not usually the thing that is best. We compete in an effort to produce something which is better in design, material and workmanship than anything else which belongs to the same general class of product. This in fact is the best kind of competition for both the manufacturer and the consumer. It is best for the manufacturer because it leads to higher efficiency and it is best for the customer because he gets a better machine.

Efficiency after all is first in importance in mechanical industries. Labor costs, overhead charges, and even material, are most affected by the question of efficiency. This is particularly true of labor costs, and as these are our principal items of expense, it is plain that through efficient methods the final cost can be very materially affected.

The high price of labor, on the face of it, controls the cost of a product, when as a matter of fact it does nothing of the kind. Other things being equal, a shop located in a place where labor is one-half that of some other place should turn out its products at nearly one-half the cost, but other things are not equal. Shops in the United States are not alike and shops located in different countries are less so. To refer to the question of labor alone, regardless of apparatus and methods, it is a fact that high wages induce men to do more work. It cannot be said that high wages will induce any man to do more work, but where wages are attractive the best men are drawn to that center, the supply is largely increased, the field is broader and the foreman is thus able to discriminate between good and bad men, letting the inefficient workman go and replacing him with one of greater capacity. Every one who employs labor knows that the personal equation of each man is different; some men can do two or three times as much work in a day as others. This is not physical capacity, but a natural something about the man which enables him to get quick results. He may use less exertion, he may even have less general ability, but he knows how to separate chaff from wheat; he seems adapted for that class of work in which he is engaged, and his productive capacity exceeds that of his neighbor because it comes natural to him.

In handling a rock drill in the heading of a tunnel some of the best men are negroes from the South,—men of low intelligence, but with a capacity to get results in that particular class of work superior to some intelligent and perhaps educated white men. Such negroes get good wages because they bring good returns to the contractor.

Given a market large enough to permit the manufacturer to build on the duplicate part system; that is, in quantities and by machinery, efficient high-priced labor and the best tools and methods will bring supremacy in any line. These conditions cannot be brought about except through a long period of years. This is especially true of labor conditions. Efficient labor is the result of growth and development in each particular industrial field. The ability which makes the man worth more than a man doing the same class of work in any other country, or in any other locality, has been acquired by practice, not entirely on his part, but perhaps by his ancestors in that field. Through good work, and ever increasing compensation, which always goes with efficiency, the best men have been drawn to that field and the whole environment makes for the best results.

Perhaps a practical illustration of this point may be of interest. During the annual meeting of the directors of a railroad company in the west an oil salesman opened the door and asked to be heard. The first impulse was to put him out, but he persistently held his ground saying that he was there to save the railroad money and as he presumed that the directors were there for the same purpose, he asked a moment's consideration. This was reluctantly given on the suggestion of one of the directors, whereupon the salesman proceeded to advocate the great advantages of his patent oil. He was referred to the superintendent with instructions to give his oil a trial. The next year the same board was in session, when one of them recalling the incident sent for the superintendent and asked him about that patent oil. "Oh, it's all right," said the superintendent, "it does the work very well." "Then," said the President, "that interruption to our meeting last year was a good thing after all, that man must have a valuable patent." "Mr. President," said the superintendent, "the value of that patent *is that man.*" While this illustrates pre-eminently the question of salesman efficiency it applies with equal force to every class of work. It is in the man.

Next to human efficiency comes the important question of methods. In this no industry can be compared with another that is not producing the same product, nor can the methods of one shop be criticised where the markets do not warrant a similar volume of manufacture. To make a thing on a small scale is one thing, to make it on a large scale is quite another, and the large scale always opens possibilities for reducing cost. The first thing of importance in considering methods is to get the best tools, and next to this is the question of handling them efficiently.

In Japan, for instance, some of the tools in the works are as good as anything seen in Germany or America, yet with all their plentiful supply of low-priced labor they do not get the results out of them. Men are paid in the Imperial Steel Works of Japan about 30 cents per day. Iron of good quality is brought from China, yet the net cost of the product is high and the works do not pay. This is partially, in fact chiefly, due to a limited market which does not warrant the production on a large or continuous scale, but were the question of cost entirely or even chiefly a question of the price of labor there is no doubt about the fact that Japan would develop a market through encroachment upon other sections of the world because of low cost of production. The low cost is not obtained and is not likely to be obtained except through an experience which must develop high-priced and efficient labor.

Germany has reached its present position of industrial supremacy not because of low-priced labor but through efficiency. German labor has been steadily going up,—in fact it has gone up faster than the labor of England or America. This is because the German industries have built up through high efficiency a higher class of workmen. In 1876 at the Centennial Exposition in Philadelphia the German representative reported to his government that in engineering mechanics Germany was far behind other nations. He went so far as to condemn German mechanical engineering to such an extent that he aroused the people of his country who classed him as a traitor, yet it is a fact that since the day of this Centennial Exposition Germany has awakened through a scare, followed by a careful study, education and work. The German industrial schools represent the groundwork of this progress. Through these schools not only are young men taught mechanical engineering, but the men at work in the shops are required to spend a certain amount of time each week in the school explaining the theory of their daily practice.

It is this study of the theory of things that has brought German engineers to the front. Every movement and each item are a subject of careful study and application. Inventive genius is encouraged to the greatest extent, materials are studied through scientific and practical tests, efficiency being the goal toward which every German engineer has been working and through which he has been able to put the products of the German works in the first rank; in doing this he has at the same time, and through the same methods, lowered the costs.

While demonstrating to an employe the manner of handling a new brand of safety explosive on April 19, William McNally, assistant foreman of the operations of the Ebensburg Coal Mining Company, at Colver, Pa., inadvertently brought two live wires he held in his hand together, with the result that he was torn almost to pieces by the explosion and died almost instantly. The workman to whom McNally was explaining the secrets of the explosive was scarcely hurt.

QUARRY OF BUFFALO CEMENT COMPANY.

WINTER OPERATIONS IN A QUARRY

BY CHARLES A. HIRSCHBERG.

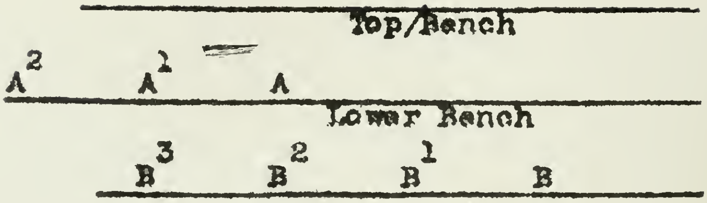
Electricity as an industrial power transmitter has many and diversified applications, which are continually being extended. A great many quarries which heretofore have been compelled to suspend operations with the advent of cold weather on account of the many difficulties experienced in keeping steam and compressed air operated tools in operation are now having recourse to electrically operated tools with results in the depths of winter which compare favorably with those obtained by the use of air or steam tools when working under ideal weather conditions.

At the quarries of the Buffalo Cement Company, Buffalo, N. Y., a general view of which is shown in Fig. 1, operations have been carried on continuously the past winter with electrically operated drills, electric-air drills. Current for these drills, which are still running continuously, is furnished by a Westinghouse 50 K. W., 220 Volt, Direct Current Generator, direct connected to an Ames 75 H. P. Steam Engine running at 250 R. P. M.

The transmission line is carried into the quarry, 1,500 feet distant from the power house, where the current is distributed throughout the quarry. In running the transmission lines, wooden poles with wooden cross arms and solid bare conductors are used, provision being made at convenient points for tapping. The low cost of installation as well as of maintenance of the electric transmission line as compared to that of the steam pipe lines of former practice, forms quite an item in the economical operation of these quarries. Time and money spent, moving pipe lines, requiring the services of a skilled mechanic, the loss in transmission, leaky joints, etc., are a few of the difficulties which have been obviated by the installation of electric air drills. Once installed the electric transmission line becomes practically permanent.

The methods of carrying on the drill operations are the same as those familiar in very nearly all quarrying operations, a few novel features, however, are especially worthy of note. The bench method is employed entirely —two continuous benches being worked, varying in height with the lay of the rock. The accompanying sketch, Fig. 2, shows the method used to obviate any necessity for moving the drilling machines, which are of the 5C Temple-Ingersoll Electric Air Type, from bench to bench.

The upper machine is kept constantly ahead of the lower machine. While the upper ma-



PLAN OF DRILL OPERATIONS.

chine is drilling at A the lower one is drilling the round at B. A and B are blasted after moving the machine to A¹ and B¹. During the drilling operations at the new stations the spoil thrown by the blast at A on to the lower bench at B² is being cleared away. In this way the time of moving the machines about is greatly reduced. Fig. 3 shows a machine at work on the lower bench.

ELECTRIC-AIR DRILL AT WORK.

The quarries of this company contain both a limestone and a black flint rock of seamy formation, with a tendency to cave in places. The latter rock is extremely hard and difficult to drill.

The drilling is all done on contract. Each machine, of which there are five, is operated without a helper, one general utility man being employed to handle steels and otherwise assist in drilling operations.

The average drilling round in the limestone consists of from 10 to 20 holes, 8 to 12 ft. deep. An average of from 100 to 120 ft. of hole per day of 9 hours is drilled by each machine. Holes are started 2½ ins. and bottomed 1¼ ins. Black powder is employed in this formation with copper exploders. Holes are tamped with a wooden bar and are shot by electric battery. But one drill is operated in this formation, where its work is intermittent, as it breaks more ground than the company has use for.

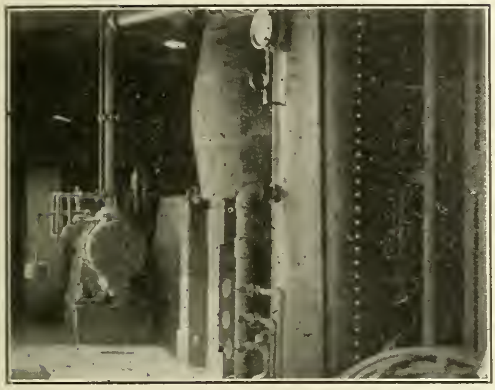
The lime rock products of this company are used for foundation and building stone. The serviceable sizes broken, being trimmed by hand to sizes carrying from 6 ins. to 12 ins. From 3,000 to 4,000 tons per year are crushed and ground for local foundry trade, by which it is used as a flux. One grade, a honeycombed rock, containing a low percentage of lime, is crushed and ground for the fertilizer trade.

In the flint formation, holes varying in depth from 5 to 12 ft. are drilled. The average round consists of 30 holes. These holes also are started 2½ ins. and bottomed 1¼ ins. They are loaded with 12 to 14 sticks of 1¼-in. Keystone 40 per cent. dynamite. The ground preparatory to being blasted is banked by rock already broken, experience having shown this to be a material aid in breaking it up small, as well as in restricting the spread of the blast. Four Temple-Ingersoll electric air drills are kept constantly at work in this formation.

The flint rock is used principally as ballast, in road building and as a filler for concrete.

An idea of the greater efficiency obtained through the use of the aforementioned drills may be gained by citing the statement of the superintendent in immediate charge, Mr. Fred G. Kuntz, that, with steam drills they were only able to obtain an average of 60 ft. of drill hole per machine per shift, partly due to the delays, experienced with freezing of machines, lines, etc., whereas with the present drills they are obtaining an average of 100 to 120 ft. under identical conditions accompanied by a saving in power of very nearly one-half.

During winter the operations in the quarries consist principally in the drilling, breaking and crushing of the various rock, preparatory to the commencement of mill operations



COMPRESSOR PLANT.

in early spring. With the advent of spring, the steam shovel, a Marion 60-ton machine equipped with either a 1½ or 2 cu. yd. dipper, and running on a standard broad gage track, is put into commission loading the flint rock into 2-cu. yd. side-dump cars, following the work of the drills closely.

Rock which is thrown aside by the steam shovel is drilled by means of two small plug drills of the Ingersoll-Rand MV 5 type, air for which is furnished by a small power driven compressor manufactured by the same company. The problem of furnishing air to these drills has been accomplished in a rather novel manner—a narrow 36-in. gage flat car was pressed into service. The compressor, motor, water barrel and air receiver were mounted thereon and completely housed. This outfit follows the work of the shovel, current for driving motor being taken from the drill transmission line. This outfit is shown in Fig. 4.

The writer's thanks are due to the Buffalo Cement Company, and especially to Mr. Fred G. Kunz, supt., for courtesies extended and data furnished.

DESIGN AND MAINTENANCE OF ROCK DRILL BITS

BY WARD BLACKBURN.

The efficiency of a rock-drilling plant is determined by the amount of power delivered to the bit and converted into cutting power. No matter how efficient the compressing plant and the rock drills, or how careful the drill operator, if the bit is dull or of incorrect shape, the rock is not cut, good energy is wasted, and money and time are lost in reaming the bore hole or in pulverizing the rock, and the real object of the work is defeated.

At most mines little attention is paid to the drill bits by anyone except the blacksmith. The drill runner is satisfied if the bits run out a change and hold gage well for the next bit to follow. The fewer changes, the better he likes it. The same is true of the blacksmith. The longer a bit is in service the less frequently must it be sharpened. The bit is designed for use as long as possible without resharpening and the cutting properties take second place.

CUTTING MORE IMPORTANT THAN STAYING QUALITIES.

In designing a good bit both cutting and staying properties should be considered, but the day of hand-sharpening and of chuck bolts is rapidly passing, and now the efficiency sacrificed to staying properties is determined largely by the cost of transportation and handling of bits and permissible loss of gage. It is not influenced to the same extent as formerly by the labor of sharpening or trouble of changing bits. The cost of transportation and handling of bits amounts to a considerable item, which increases as the lasting qualities of the bit are replaced by cutting qualities, so that it often governs the extent to which the design may be changed.

Light, compact mechanical sharpeners can now be obtained at a reasonable price, and as these machines reduce the cost of sharpening to a low figure and enable the blacksmith to make several hundred bits per day, shop considerations offer no serious reason for retaining merely staying qualities in the design of the bit. Nearly all rock drills can be provided with a wedge chuck, or some means of holding the bit behind chuck keys so that bits can be changed in a fraction of a minute. This largely overcomes the objection to short bits. In several mines the cost of transportation and handling of bits is greatly reduced by installing the power sharpener with oil or coke furnaces underground.

Allowable loss of gage is an important factor, for the greater the loss the larger must be the diameter of the shorter bits to insure a certain diameter of hole at a fixed depth. This larger diameter means a loss of power, so this point can never be lost sight of in determining the bit to be used. Operators who believe the gage should be retained irrespective of the amount of power used run the edges of the wings of the bit back about one inch in a line parallel to the axis, making the bit a reaming tool. If this is done, as soon as the cutting edges wear a little the shoulders begin to bind and stick against the sides of the hole, and it must be reamed out to a size which will allow the bit to move forward. When such a bit is removed from the hole it will show greater wear on the edges of the wings than on the cutting edges. As the bit is apparently as hard ½ in. back, as on the cutting edge it is reasonable to suppose that there has been as much work done in wearing the steel of the wings as in wearing an equal amount at the cutting edge, that is if the reaming edges show more wear than the cutting edges, it is to be supposed that they have done at least as much work as the latter. In other words, as much if not more power has been expended in reaming the hole as in cutting it; half the power has been used in cutting an area of say seven sq. in., that of a 3-in. circle, and half the power has been used in reaming an area of a little more than ½ sq. in., the area of the 1-16-in. rings reamed out. Furthermore, the rock drill is designed to cut rock by means of a blow. It is not a reaming machine, and as soon as a bit is cutting or reaming the side of the hole it is retarding the action of the drill. This strains the rotation and has a tendency to twist and break the bit. Power expended in reaming is power lost. From this it is apparent that because of the rapid loss of power and the wear and tear on the rock drill, little of the efficiency of the bit should be sacrificed to the reaming qualities.

It is sometimes claimed that unless the bit has reaming edges, the hole will become rifled. This was true to some extent when the bits were forged by hand, but it was due to the difficulty of getting each corner or wing equidistant from the center of the bit. With most power sharpeners this difficulty is removed, and with the correctly formed bits there is little trouble from rifling.

WHAT CONSTITUTES A GOOD BIT.

While it is true that one bit cannot be selected as a standard for any and all classes of rock, still the power-sharpener manufacturers, especially those who have gone into the study of drill bits, are gradually working towards a few standard types. The concensus of opinion is that under average conditions a good bit for power-drilling work should embody the following points:

(1) It must take full advantage of the chipping and fracturing of the rock. In a bore hole there is a certain depth to which the rock will fracture when struck by a sharp tool. If the tool is driven deeper than this it will not fracture the rock, it will crush it. If the cutting edge of the bit is blunt it will not get full advantage of the fracture, and considerable of the force will be expended in crushing or pulverizing. The bit acts as a wedge.

(2) The wings of the bits should be as thin as is consistent with standing-up quality to allow for the ejection of the cuttings. If the wings are left heavy there is little space for the escape of cuttings and consequently they are held in front of the bit and continually churned and ground, the bit does not easily reach solid rock and the blow loses a large proportion of its cutting power before it reaches the rock.

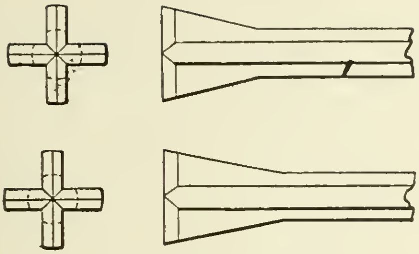
(3) The bit must be perfectly free in the hole at all times; because of the tendency of the rock to fracture, the drill hole will be a trifle larger than the cutting edge. If the bit is so designed that the cutting edge is its greatest diameter and will practically remain so until dull it will always remain free in the hole.

(4) The bit must allow equal wear on all corners. If the bit is not symmetrical, that is if the ends of all the cutting edges are not the same distance from the center of the bit, the longest end will cut a groove in the side of the bore hole and a rifled hole will result. Furthermore, the wear is unequal and the extra strains in the steel often break it. The rotation of the drill is impeded and the parts subjected to excessive wear.

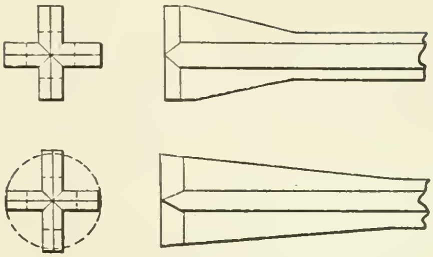
(5) The bit must be dressed in a manner consistent with the treatment of good steel. It must not be overheated, or worked while too hot. Light rapid blows should be used in forging. The bit must be tempered properly. The proper temper should be determined by experiment and rigidly adhered to. The bit should be allowed to cool thoroughly after forging and should then be reheated for tempering. It should never be sharpened and tempered on the same heat.

BITS SHOULD FRACTURE THE ROCK.

In Fig. 1, are shown bits designed to fill these requirements. An angle of about 90 de-



Correctly Made Bits
FIG. 1.



Incorrectly Made Bits
FIG. 2.

grees for the cutting edge is generally accepted as the correct angle. If the angle is greater the bit has a tendency to crush rather than fracture the rock, and as a rule the bit cuts slowly. An angle less than 90 degrees gives a bit which will cut fast, but it has a tendency to break off and wear rapidly. There is also a tendency for it to enter the rock, especially soft rock, past the point of fracture and expend energy in crushing or wedging out the rock. The "mudding" powers are greatly diminished. The thickness of the wings may range from ¾ in. on a large steel to ⅜ in. or even less on a stoper and hammer-drill bit. The wing must not be so thin that it breaks off, still, the less stock necessary the better the clearance for the cuttings.

The third point is probably the hardest to comply with. When the bits shown in Fig. 1 are first placed in the hole the cutting edge is the largest diameter, and as it may be safely assumed that the rock will fracture 1-16 in. beyond the bit, the latter must be free in the hole. The wings of the bit taper in the ratio of one to four, or one to five, and as the cutting edge wears a shoulder or reaming edge forms on the wing. When it wears between 1-16 and ⅛ in. from each wing a shoulder ¼ to ⅝ in. forms and there is a point between these where the cutting edge is fracturing the rock in the side of the hole to a diameter equal to the diameter of the bit through the shoulders. In other words, the shoulders of the bit are just touching the sides of the hole. If the bits run past this point, the cutting edge will not cut the hole to a diameter large enough to admit the bit and the shoulders immediately become reaming surfaces.

The taper of 1:4 or 1:5 is determined upon a medium. If less taper is used, say 1:7, the shoulders become more prominent and the cutting edge has less allowable wearing surface before the bit binds in the hole causing the shoulders to become reaming surfaces. If the wings have a greater taper, say 1:2, the wear is excessive, and the loss of gage prohibitive. The sharp taper leaves the ends of the cutting edge in a weakened condition and they easily break and chip off.

MACHINE SHARPENERS MAKE UNIFORM BITS.

The necessity for having the drill bit concentric is obvious. In hand sharpening and even with some power sharpeners it is not uncommon to find one of the ends of the cutting edges protruding 1-32 to 1-16 in. beyond the others. Some sharpener manufacturers have effectively overcome this difficulty by entirely inclosing the bit under a heavy pressure while it is being forged. When this is done there can be no question as to the corners falling within a circle.

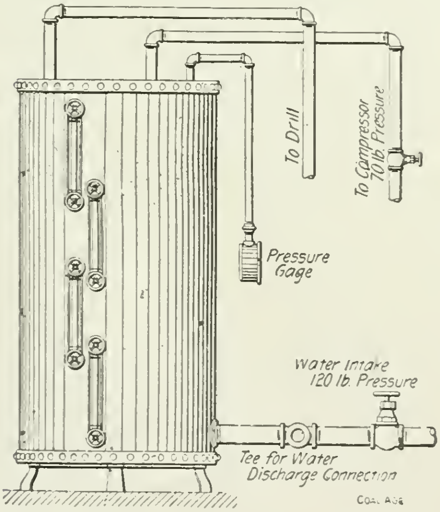
The tempering and manner of heating and treating the bit is generally left to the discretion of the blacksmith. This is a mistake as a little attention and study given the subject by the manager or superintendent will often result in marked improvements. Many kinds of steel now on the market, and the scientific methods of treatment are entirely new to the average smith.

A word should be said about mechanical sharpeners. These machines have been greatly improved in the last few years, and now extremely light, simple designs of remarkably high capacity and efficiency are within the reach of all. The bits dressed in the sharpener are always perfect in form and gage and everything considered, will give from 25 to 50 per cent. greater efficiency than if sharpened by hand. In addition to the increased speed of drilling there is a noticeable saving in the wear and breakage of machine parts and the bit itself lasts longer and wears much better.

When installing a power sharpener one should not lose sight of its main advantage, increasing the efficiency of the drill bit. It should be installed with the idea that because of the marked reduction in the cost and time of sharpening one can afford to furnish the drill with better steel more often. It is impossible to make a hard and fast rule as to when a power machine should be installed, but it is certain that a sharpener will effect a material reduction in cost per steel dressed, lessen the machine repair parts required, save steel and steel breakage, and greatly increase the drilling speed of machines.

TESTING AIR CONSUMPTION OF DRILLS

Nearly all users of drills find it necessary or desirable from time to time, especially when about to undertake important new work or when about to purchase a large number drilling machines, to determine the performances and relative efficiencies of the various types of drills found on the market. The arrangement described in the following paragraphs has been satisfactorily used in conducting such tests on different forms of compressed-air drills.


To Drill
To Compressor 70 lb. Pressure
Pressure Gage
Water Intake 120 lb. Pressure
Tee for Water Discharge Connection
Coal Age

Air Tank and Connections

As shown in the illustration, a vertical air receiver is connected to the compressor line by a 1-in. pipe, fitted with a globe valve, and a 1-in. outlet pipe is led from the receiver to the drill. Water gages are placed one above the other throughout the entire height of the receiver, and a pressure gage is supplied. At the bottom of the receiver a 3-in. pipe with globe valve furnishes a water supply, and between the receiver and intake valve a tee connection is provided as a discharge.

Before starting the test, water is allowed to flow into the receiver until it is just visible in the lower gage, and a chalk mark is made opposite this level. The receiver is then filled with air at the desired pressure, the air shut off and the test begun. As the drill takes air from the receiver, the operator maintains a constant pressure by regulating the water valve. Simultaneously with the stopping of the machine a chalk mark is made at the water level then shown by the gage and the water drained off in preparation for the next test.

TABLE I. TEST OF AIR DRILLS

Name of Drill . . . .

Cyl. Diam. Stroke Feed Weight

Condition.

Test No	1	2	3	4	5	6	7	8	Average
Air pressure, (gage), lb. per sq. in									
Size of bit, in.									
Net time of run, min. .									
Depth drilled in ft. . .									
Rise of water in tank, in ft.									
Depth drilled in ft. per ft. rise in tank									
Depth drilled per min. in ft									
Cu. ft. free air per min. .									
Cu. ft. free air per ft. drilled. . . .									

Remarks . . . .

The distance between chalk marks, depth of drilled hole and time of drilling are noted. The cross-section of the tank being known, the distance between the chalk marks makes it possible to find the volume of air used, at the given pressure, and from these figures the amount of free air can be computed. A convenient form for arranging the data and results of the test is shown in Table I. The average values obtained for the last three items in the table give the information that is usually desired in this connection.

It may happen, however, that in spite of the control provided by the water supply, the air pressure will decrease during a test. In this event, the amount of free air used may be calculated as follows:

Let
P = Initial pressure,
P_1 = Final pressure,
B = Height above initial water level to top of receiver,
A = Cross-sectional area of receiver, in sq. ft.,
R = Rise of water in receiver, in ft.,
H = Atmospheric pressure.

Then each foot rise of water in the tank represents the consumption of A cu. ft. of air and if the pressure had remained constant at P, the volume of free air used would have been given by

$$V = RA \times \frac{P + H}{H}$$

However, the expansion of the air that remains in the receiver, from pressure P to P_1 represents the consumption of a volume of free air equal to

$$V_1 = A\ (B - R)\ \left(\frac{P + H}{H} - \frac{P_1 + H}{H}\right)$$

and the total amount of free air used is then $V + V_1$.

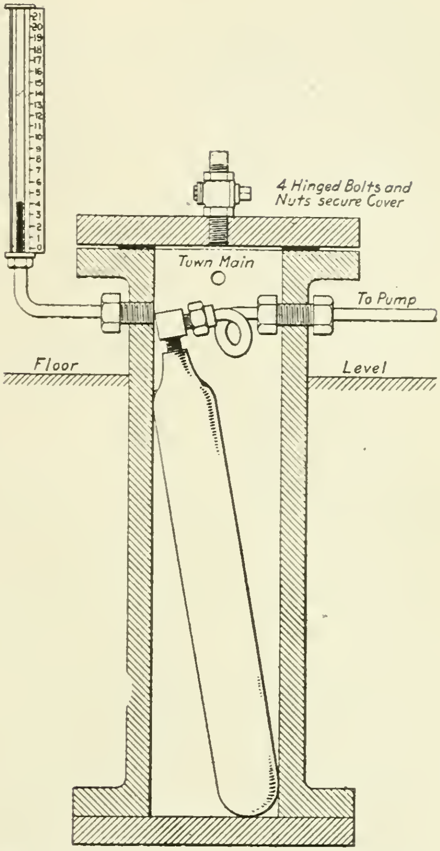
It may prove more simple to let V represent the initial amount of free air in the tank at pressure P and V_1 represent the final amount of free air at pressure P_1. Then

$$V = AB\frac{P + H}{H}$$

$$V_1 = A\ (B - R)\frac{P_1 + H}{H}$$

and $V - V_1$ will give the amount of free air consumed during the test.—*Coal Age.*

In a report by the secretary of the French Aero Club, relating to aviation in France during 1911, the following figures indicating the development of aeronautics are given. In that country alone 13,000 flights were made across country, and in total, 1,625,000 miles was covered; the total time that aeroplanes remained in the air was 30,000 hours. The English Channel has been crossed thirty-seven times. The accident record has decreased, and during the year 62,500 miles were flown for every fatal accident.



MEASURING THE ENLARGEMENT OF GAS FLASKS AT HIGH PRESSURES

The flasks here treated of are often used for the storage of high pressure air, which gives special interest to the description of the ingenious apparatus employed in England for testing them as to elastic limit and permanent set as described by Mr. A. L. Haas in a recent issue of the American Machinist.

Refrigerating machines using CO_2 as a medium for the elimination of heat have become general in England. As supplied the gas is in liquid form in steel flasks made from drawn tube 5-16 in. in thickness; one end of the flask is necked to receive valve, the other is welded to hemispherical form.

Certain precautions are essential to the handling of the flasks, and the necessity for stringent regulations and tests is apparent from an accident which occurred several years ago when a man and cylinder were blown to atoms at a railway station. Subsequent to this, a commission sat and its findings were incorporated in the form of a report and recommendations concerning manufactured material, annealing and tests of finished flasks.

With regard to empty flasks, sufficient care is even now not exercised. For instance, it has been known that empty flasks were used as rollers in moving heavy machinery. This misuse should be legally discouraged as the flasks in course of time are refilled and the stresses set up by such mishandling may have disastrous results.

The usual quantity of CO_2 in a flask is ¾ lb. for each one pound water capacity. If flasks have to pass through the tropics the quantity is reduced 25 per cent. An increase in temperature from 65 deg. to 100 deg. F. increases the pressure about 1,000 lb. per square inch. One purchaser of filled flasks for export through the tropics specifies 1,800 lb. per square inch as the maximum when filled.

Most large buyers of filled flasks use specifications based upon the findings of the 1896 Commission. The principal clauses insisted on are as follows: 1. Flasks are to be made of the best quality mild steel containing not more than 0.25 per cent. carbon and not less than 99 per cent. iron. 2. Flasks are to be hydraulically tested to a pressure of 3,360 lb. per square inch and are not to show a permanent stretch or enlargement of their cubic capacity of more than 10 per cent. of temporary stretch under test.

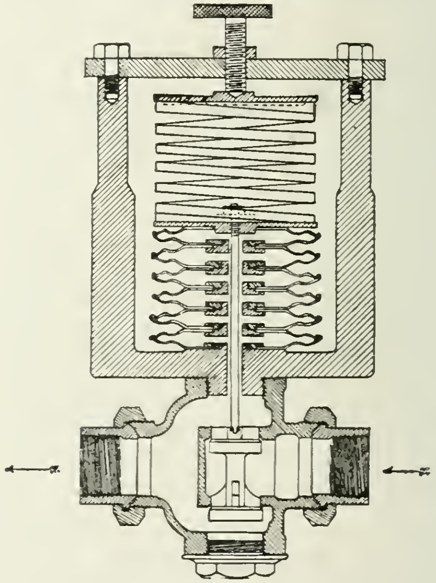
Clause 2 is rather puzzling at first sight; the method and apparatus used for measuring the stretch will prove of interest. The diagram shows the essential features. There is first a cast-iron cylinder partially sunk below the floor level and having a connection to a glass tube with scale attached on one side and a connection to the pump on the other.

The pump connection terminates in a nipple inside the cylinder. A cast-iron cover pointed with a sheet packing ring provided with a cock, completes the outfit. An ordinary hydraulic hand pump is used. Water for filling the cylinder is from the street main through the connection shown.

The flask to be tested is filled and lowered into the cylinder. A short length of copper pipe with two unions makes the connection from the pump nipple to the flask. The cylinder is then filled from the main and the cover jointed on. Additional water is run in until the graduated tube shows zero, then the water-main connection is shut off.

Next the flask is pumped up to the 3,360 lb. pressure by gage. The water level in the tube now shows an increase from zero to say division 20. The pressure on the flask is released, the level in the tube dropping simultaneously. The permanent set is shown as the difference between the zero and the final level and its percentage of the maximum is easily ascertained.

With one man filling flasks and two more attending to the apparatus 30 flasks an hour are easily handled. The apparatus as will be seen makes full provision against imprisoned air which would render the test unreliable.



THE ZIERMORE PRESSURE REGULATOR

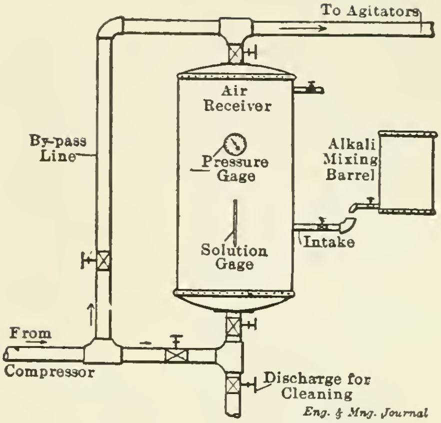
The cut shows the essential features and the mode of operation of the Ziermore pressure regulator, the purpose of which is to maintain a uniform delivery pressure of steam, air or gas no matter how much the pressure of the supply may fluctuate. The flow through the apparatus is in the direction of the arrows, and it will be seen that the delivery side is in direct communication with the diaphragms in the chamber above. An increase of internal pressure will of course tend to distend each diaphragm, while a decrease of pressure will permit the spring above to overcome the pressure effect. The cumulative movement of the six diaphragms is all transmitted by the central rod to the valve below which controls the flow. This valve is balanced and moves without friction, so that its change of position from little or no flow to the full pipe capacity requires only a minute change of the delivery pressure. The pressure which the valve is set for at any given time cannot be exceeded, and the pressure can only fail minutely as long as the supply of fluid is maintained. The screw above provides for the adjustment of the spring tension according to the pressure desired to be maintained.

It will be seen that this is a very simple device and in service it may be placed either vertically or horizontally or in any position most convenient. The apparatus is made entirely of metal and is specially designed to avoid corrosion or deterioration. The interchangeable diaphragms are German silver and the entire regulator is of bronze up to and including the 1½ in. size, with cast steel bodies for those which are larger. It is made in all the regular pipe sizes up to 5 in. and will stand all pressures up to 300 pounds with delivery pressure whatever may be desired. Made by the Ziermore Regulator Company, Johsonburg, Pa.

PURIFYING AIR FOR AGITATING PULP

At a number of cyanide plants in the United States, the compressed air that is to be used for aërating the sand or slime, or in agitating the pulp, is purified by filtration before use. Several types of filters are used; at the Homestake plants the air is passed through a filter-press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. At the Alaska-Treadwell concentrate-cyanide plant, the apparatus described by W. P. Lass and shown in the accompanying illustration, is used.

Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The Homestake presses do this effectively by the filter cloths retaining the oil and other solid impurities contained in the air.



Eng. & Mng. Journal

ALASKA-TREADWELL AIR PURIFIER

The apparatus herein illustrated has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

PLACING AIR PIPES IN SHAFTS

Extensions of the compressed-air mains in the Champion shafts of the Copper Range Consolidated Co., in the Lake Superior copper country are made in 200-ft. lifts. The work is commenced by placing a tee in the shaft opposite the station at the bottom of the lift, then carrying up the piping for 200 ft. to connect with the air main already in position.

The tee at the lower station is securely fastened by an iron yoke to a carrier timber. The pipes are then lowered and put together until the next level above the station is reached. There another tee is put in the line, immediately above and below which yokes are used, both to anchor the main and to prevent swinging at that point. When this tee has been put in place the other pipes are lowered and, by using a pipe of the necessary length, the top of the extension is brought to within six or eight inches of the bottom of the main already in place. A flange is screwed tightly home on the upper end of the top pipe and yokes are attached to anchor the line in position.

The connection with the part of the main already in place is made after 1 p. m. on Saturdays, at which time no drills are running in the mine, so that the air can be shut off without interfering with mining work. Jacks are placed under the lower end of the extension pipe and the yokes are loosened so that all the weight comes on the jacks.

The blind flange on the lower end of the part of the shaft main already in place is removed. The flange on the upper end of the extension is turned in the direction of unscrewing so that the bolt holes in upper and lower flanges are in line. The little loosening usually necessary does not cause leakage. Then the 200-ft. length of pipe is raised by the jacks until the flanges come tight together. The flanges are then bolted together, usually with a gasket between to make a tight joint. The yokes, of which there are two for each 100-ft. length of pipe, are then tightened to hold the main in position.

During the operation, large wrenches are used to prevent turning of the upper part of the line when the extension is being raised. Making the connection takes an hour; two men are needed at the jacks, four at the yokes and two, with the boss timberman at the point where the connection is made.—*Enginerring and Mining Journal.*

ELECTRIC HEATER FOR AIR DRAINS

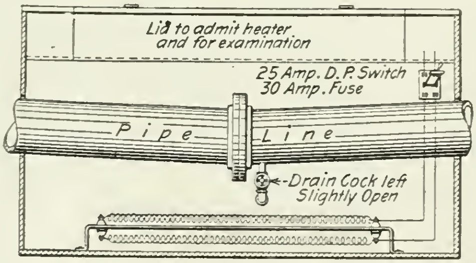
BY G. C. BATEMAN.

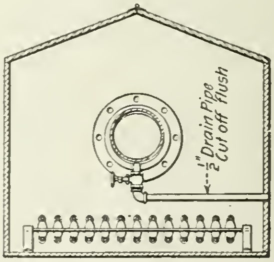
When the Cobalt power companies first started to supply compressed air on a large scale to the mines, trouble was experienced in the winter by the water from the air collecting in the low parts of the pipe lines and freezing. In the pipe lines of the British Canadian Power Co., this difficulty was overcome by the use of an electric heater, designed by James Ruddick, the general superintendent for that company. The device consists of a heater which is placed in a small box built over the drain cocks in the pipe line. These drain cocks are placed wherever there is a drop in the line, so that the water will drain both ways to the cocks.

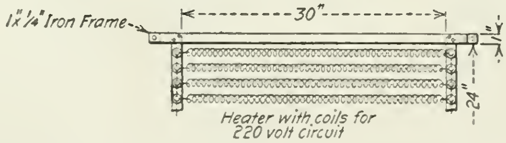
The heater, which is placed underneath the drain cock, is so designed that it fits snugly into the box, and a pipe leads from the cock to the outside of the box. This pipe is cut off flush with the box so that there is no danger of freezing on the outside. The frame of the heater is made of 1x¼-in. iron, and on this frame insulation knobs 1 in. in diameter and 1½ in. long are mounted back to back, as shown in the accompanying illustration, one bolt being sufficient for the two.

The coils are made by winding No. 14 galvanized-iron wire on a ⅞-in. rod, each coil consisting of 100 turns. The heater takes 220 volts, each coil being equivalent to 11 volts and 20 amperes. The coils are arranged so that there is at least an inch of space between them. There is a double-pole switch with 30-ampere fuses in each box and the wiring is mounted on cleats to prevent fire. Although the heater takes only 20 amperes the stronger fuses are used to take care of the current when starting, as the coils take more current when cold than when warm. The power required is 4 kw. for each heater.

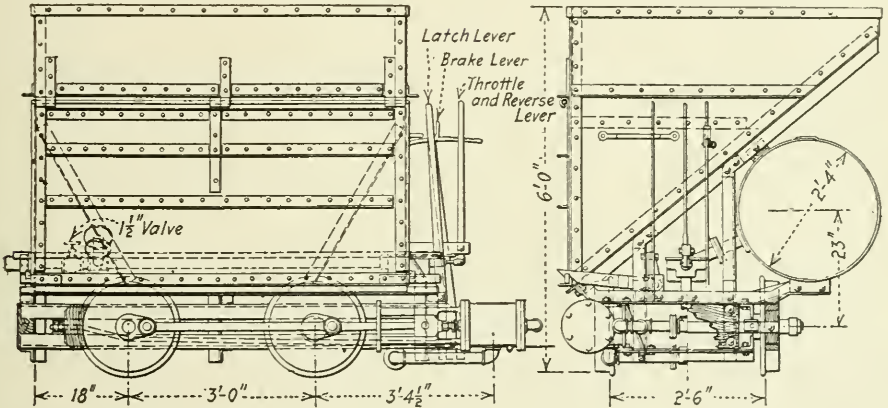
The British Canadian Power Co. controls about 15 miles of pipe line between 6 and 10 in. in diameter, and several miles of smaller sizes. There are about 25 heaters in use, and since their installation no trouble from freezing has been experienced.


Lid to admit heater and for examination
25 Amp. D.P. Switch
30 Amp. Fuse
Pipe Line
Drain Cock left Slightly Open





This device can be used advantageously wherever there is trouble from the freezing of surface lines, and as it is a simple device it can be built at the property. For pipes of smaller diameter than those mentioned, a heater of about half of the capacity of the one described can be used, in which case it would be necessary to have current at 110 volts, or less, and sufficient coils can be connected in series, to suit the voltage available. To increase or lower the voltage of the heater, it is only necessary to add or take out coils as the case may be. Should it be found that the heater does not warm up sufficiently, a coil or so can be cut out.



AIR DRIVEN SIDE DUMP CAR

BY S. A. WORCESTER.

The car illustrated in the accompanying drawing was designed by me for use at a mine in which electricity cannot be conveniently used for this work, but air at 100 lb. pressure is available in the mine. The car has to make a maximum trip of 300 ft. loaded and return empty. A 28x72-in. air receiver is mounted on the car frame and is automatically recharged after each trip while at the loading station. A brass male coupling on the car which is connected to the receiver, enters a corresponding female stationary coupling as the car strikes the bumper at the loading station. When the couplings are brought together the stems of two check valves encounter each other and both are opened, thus admitting air from the stationary air line to which the female coupling is attached, to the receiver on the car. When the car starts away, separating the couplings, the pressure instantly closes the check valves, thus preventing any loss of air.

The engines are of simple construction and are made so that as few adjustments as possible are necessary, for they are used by unskilled operators. The construction of the car is inexpensive, the number of parts being few and the same pattern being used for both engines with but few and slight changes. The engines are reversed and controlled by a single throttle and reversing slide-valve in front of the operator and exactly similar to the slide-valves of the engines. Moving the lever controlling this valve in either direction starts the car in the corresponding direction and placing it vertically shuts off air from the engine.

The axle bearings and rod bushings are made of cast iron and are of the simplest construction. The crossheads are made of cast iron turned to fit the guides, and are equipped with straight pins. The cylinders are cast in one piece with the valve chests and front heads. The pistons are riveted to the piston rods which are screwed into the crossheads. Plain snap rings are used for piston packing. The eccentrics are cast on the drive wheels, and eccentric straps and rods are forged in one piece and valve stems are made without any adjustment for length, so that when set they cannot be moved out of adjustment by unskilled operators. The brake has ample leverage and few parts. It is equipped with a pawl or latch which is used for holding the car in place against the pressure at the air coupling, which is sufficient to push the empty car away it the brake is not set. The car door latches are lifted by the lever at the left of the operator and all three operating levers are nearly vertical and close together, making a convenient and safe arrangement. The speed of this car, unlike that of most electric-motor cars, is almost unlimited, the 7x7-in. cylinders giving ample power. The air consumption is small.—*Eng. and Min. Journal.*

COMMERICAL VALUE OF THE AIR LIFT*

BY F. S. MILLER.

For a long time pumping with an air lift has labored under several handicaps which have prevented its taking the proper place among the engineering problems of the commercial world, which its merits would warrant. One of these handicaps has been the facility with which piping has been placed in wells and certain results obtained, without regard to their proper proportioning for the work to be done. Then, many a plant engineer has inserted some kind of a turned up pipe or nozzle, and, securing an improvement upon the first crude installation, imagines that he has solved the problem. We constantly run across such men who tell us that their air is the best ever, and refuse to discuss any further improvement. Then, again, many assert that all that is necessary is to convey the water to the proper depth and any kind of an old nozzle or opening will do the work.

Another handicap has been caused by the compressor people themselves who have only thought of the compressor sales and have not followed up the installation and seen that it was properly done, letting well enough alone as long as the customer was satisfied, when with a little more care they could have secured a much more economical plant.

This has resulted in the air lift being classed as a very uneconomical method of pumping from deep wells, whereas an up-to-date, properly installed air lift, where the conditions are right, all things being considered, is the most economical method for securing deep well water.

It is a great temptation to compressor salesmen to start in and dwell upon the good points of their compressors, paying little attention to the well end of the proposition. This we believe is a mistake. In order to secure proper installation, it is necessary to be more or less familiar with the geological formation in which the well or wells are located, and this becomes a fascinating study, and one that will repay the customer intending to install an air lift.

Wells may be grouped under two general headings, gravel and rock. Under the first is included sand and quicksand wells.

GRAVEL WELLS.

One of the first things to be determined is the kind and location of the strainer. The best strainer for air lift work from beds of gravel or coarse sand is a perforated strainer with openings large enough to admit the fine sand. Then with the 20th century method of sealing and back-blowing a well, the sand can be drawn into and pumped out of the well and the coarser material gradually collected around the outside of the strainer in sufficient quantities to offer an area large enough so that the water percolating through will not have the velocity to carry the sand with it. The output of wells of this kind can often be increased, if not doubled, by back-blowing.

The writer has just finished developing a well of this kind that had 1,000 ½-inch holes in a strainer located in mud and gravel. With two or three days' blowing we increased the discharge from 200 to 370 gallons per minute, thus practically doubling the value of the well.

Many wells that have been driven with the intention of using a deep well pump, or in which perhaps a deep well pump has been used for years, are equipped with a Cook strainer, or other make having fine slots, whose purpose is to keep the sand out of the well to protect the working barrel and valves. These wells, it will be found, have greatly diminished in supply, which nine times out of ten is caused by the sand choking up the openings in the strainer, and the treatment of back-blowing will put the well back to its original capacity.

The question is often asked, Will not the well choke up again? But suppose it does; it is only a question of a few moments' manipulation of the valves already installed with the 20th century lift to back-blow it and clean the strainer. Thus the clogging up does not become a matter of serious consideration.

In studying the supply of water secured from gravel or sand, it is always well to know

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Middle States Ice Producers' Exchange, Louisville, April, 1912.

whether the well has been driven into a pocket or live strata. If the former, and a large supply of water is to be pumped, then it may soon be exhausted; but if the wells are in live water strata of sand or gravel, which are renewed from a stream of water or water shed, then the supply is practically inexhaustible, and it is a question of getting the water into the well.

ROCK WELLS.

Rock wells are of a more uniform supply, and the record of wells in the same strata will give a guide to go by, taking into consideration the topography of the country. Although back-blowing will clean out the rock crevices in the seamy rocks, it rarely causes so much of an increase as in gravel or sand wells.

About the most deceitful well in the business is the flowing well. We have often heard customers state that they have a very strong well because it flows, and that it has a shut-in pressure of several pounds. The fact that the well flows does not indicate that it is a strong well, for the strata may be so tight that the relieving of the head will not materially increase the yield, and more often overflowing wells may be pulled as far as possible with air without materially increasing their supply. On the other hand, if it is a rock well full of crevices or sand rock, the yield will be almost unlimited. Such wells should be carefully studied by getting the data from neighboring wells, or by testing them out.

In order to get an intelligent estimate for pumping with the air lift, the following data are required:

Number of wells.
Depth.
Diameter of casing.
Depth of casing.
If bore reduced, at what depth.
Character and depth of water strata.
If strainer, give description and depth.
Static head.
Estimated drop.
Elevation.
Total lift.
Horizontal discharge (gravity or pressure).
Pumping submergence.
Gallons per minute required.

GENERAL OPERATION OF THE AIR LIFT.

For many years after Dr. Pohle brought out the theory of the formation of alternate plugs of air and water, this idea has been followed, care being taken only to obtain sufficient submergence to secure the best results, and when an over-all efficiency of 25 per cent. was secured, they were more than satisfied.

Within a few years experiments have been worked out along the line of getting a perfect mixture or emulsion of the air and water in a jet, and it was discovered that by using more air and less pressure, and proportioning the eduction pipes in a correct manner to a large extent, the same efficiency could be obtained through a wide range of submergence.

In the test above mentioned at Pittsburgh, Pa., where the lift was 70 feet and the submergence 35 feet, a constant discharge was maintained with an efficiency of 30 per cent.

In speaking of efficiency we mean the b. h. p. in the steam cylinders or at the belt wheel, taking account of the friction and volumetric loss in the compressor, and the loss in friction and temperature conveying the air from the compressor to the pump in the well as compared to the foot pounds of work done or theoretical h. p.

In this connection it is well to call attention to the fact that in low submergence, a larger sized eduction pipe and pump should be used than when working with a high pressure; first, on account of using low pressure, less initial velocity is secured, and second a greater volume of air must be used to pump the same amount of water. For instance, for pumping 200 gallons of water per minute with 60 to 65 per cent. submergence, on lifts up to 100 feet, a 4-inch pump and discharge pipe is of ample capacity, while with a submergence of 35 to 40 per cent. at least a 4½-inch pump and pipe should be used. With lifts of 150 feet and above, it is an advantage to enlarge an eduction pipe to take care of the expansion of the air as it travels with the water to the point of discharge, a safe rule being expansion of one size for every 150 feet of discharge line.

Care should always be taken to secure a large enough air line to reduce the friction. While an 1¼-inch air line would be large enough to use with a 3-inch pump under conditions of 80 to 100 feet lift, it would be too small for the same pump with a 200 foot lift, for the well should have a larger air pipe on account of having to carry more air to do the work. It sometimes happens, however, that the size of the well will not admit the use of a larger size air line. Then a higher pressure will have to be used to force the amount of air through at a loss of efficiency.

Compressed air does its most efficient work lifting water perpendicularly and without change of direction until the desired lift has been accomplished. Care must always be taken in these installations, if the water comes into the well above the pump, to see that there is enough area left for the down flow of the water between the walls of the well and the outside of the pump.

In regard to horizontal discharge, it is always best to arrange the plant to discharge under an umbrella separator and take care of the horizontal flow by gravity. If this cannot be done, a water ell can be used, but should be carried up high enough to give the gravity flow and the horizontal pipe enlarged sufficient to permit the air passing to the top of the pipe and flowing with the water, without having to do any work.

It is sometimes necessary to pump through a long horizontal line, where the point of discharge is higher than the well top. When this cannot be avoided use long radius bends, and as few as possible, and add a percentage to the lift in figuring the amount of air needed. So much greater economy can be secured with the straight lift and separator that this installation should always be used wherever possible.

Compressed air, when expanding, absorbs heat from different substances it comes in contact with, so that the use of air to lift water, when properly applied, tends to cause a drop in temperature. This is especially noticeable in water of high temperature.

In the ordinary air lift, where a large volume of air is used so fast that it does not have time to lose the heat of compression, or where the air is used in plugs and does not come in contact with all the water, this effect may not be secured. With the 20th Century lift, however, where a small amount of air is used, a perfect expansion takes place, and the particles of air and water are thoroughly broken up and mixed together, and the expanding air comes in contact with all the water, causing a marked reduction in waters of high temperature.

In the manufacturing of ice, you are of course perfectly aware that a saving in power or increase in output is secured by the lowering of the temperature of the water a few degrees. Hence, the use of a properly installed air lift, especially in the South where the water temperatures are higher, not only produces the amount of water required at a less cost, but puts the water in condition to do more work.

COST OF PUMPING WITH COMPRESSED AIR.

We will take the following example:

Amount of water to be pumped per minute	100 galls.
Total lift	60′
Submergence	90′
Actual free air required per minute	33 cu. ft.
Working pressure including air friction	45 lbs.
I. H. P. in steam cylinder	4.2
Steam consumption in straight line air compressor	45 lbs. of steam per 1 H. P.
Evaporation of water per pound of coal	7
Pounds of steam required per hour	189
Pounds of coal required per hour	27
Cost of coal per ton	$2.00
Cost of coal per pound	1c
Fuel cost per hour	27c
Gallons pumped per hour	6000
Fuel cost per thousand gallons	4.5c

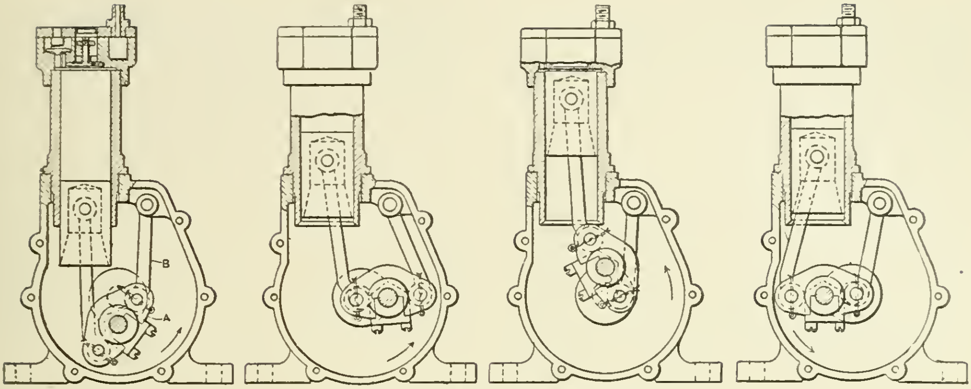
Another thing to be taken into consideration is the reduction of up-keep, as the air lift removes all chance of repairs in the well and places the only machinery used in the power plant under the eye of the engineer.

THE WHISTLING JUGS OF PERU

The potters of ancient Peru used to manufacture an ingenious musical instrument which may very properly be called a whistling jug. In collections of antiquities it is called a silvador or silvio. Specimens are obtained from the ancient burial places of Peru. One of these consists of two vases, whose bodies are joined one to the other, with a hole or opening between them. The neck of one of these vases is closed, with the exception of a small opening in which a clay pipe is inserted leading to the body of the whistle. The closed neck of this double vase is modeled into a representation of a bird's head.

When a liquid is poured into the open-necked vase, the air is compressed in the other, and in escaping through the narrow opening is forced into the whistle, the vibration producing sounds.

Many of these sounds represent the notes of birds; one in the collection at the British Museum imitates the notes of the robin or some other member of the thrush tribe peculiar to Peru.



NOVEL AIR COMPRESSOR MOVEMENT.

NOVEL AIR COMPRESSOR FOR AUTOMOBILES

The sectional cuts here reproduced from Machinery show the essential features of a small compressor built by the Hartford Machine Screw Company for use on automobiles. It serves for inflating tires and also will supply compressed air for the automatic engine starters which are now becoming numerous. It is driven through gearing from the main engine shaft with ready means for engaging and disengaging. The ingenious mechanism for operating the piston, here shown in different positions, gives the piston a travel double the crank throw and makes the machine much shorter and more compact than if a full throw crank and long rod were used. There are, of course, five joints to wear instead of two, but as the compressor is run only a small portion of the time it may be expected to last a long time without repair.

The compressor is single acting, the valves, both inlet and discharge, are in the head, and the clearance is small. The base of the cylinder is ground, as is also the piston, and no packing rings are used. The compressor casing is made of aluminum.

BLOWING AND SUCKING CAVES OR WELLS

In recent years the occurrence of blowing wells has been reported at many places in Europe and America. Those in the United States have been studied by the Geological Survey, and their phenomena are now fairly well understood. The Survey has recently published statistics of the distribution of such wells.

The names "weather well" and "barometer well" often locally applied to wells that blow and suck reflect the popular belief that the behavior of these wells is governed in some way by the weather; and this belief is in the main correct, i. e. the phenomena, in a majority of cases, depend upon fluctuations in the barometric pressure, and these in turn are broadly related to changes in the weather. One of the first persons to test this hypothesis experimentally was Prof. J. T. Willard, of the Kansas State Agricultural College. Having heard of a well of this character at Winona, Kansas, he visited the spot, sealed the top of the well airtight by means of mortar and plaster of Paris, and inserted a small brass tube connecting the well with a gage. The latter consisted of a U-shaped glass tube, the bend of which for several inches up was filled with water. The fluctuations in the level of the water, read by means of an attached scale, indicated the direction and force of the air movement at the top of the well. By comparison with readings of a mercurial barometer it was shown conclusively that the air in the well exerted a pressure outward when the barometer fell, and yielded to the pressure of the outer air when the barometer rose. The explanation of the ordinary phenomena of sucking and blowing wells is, therefore, that a body of air, inclosed in the earth and communicating with the exterior by only one or a few small orifices, sets up strong outdrafts and indrafts in adjusting its tension to that of the air outside. It must not be supposed, however, that the inclosed body of air in question is merely that contained within the well itself. The volume of the latter would probably be far too small to produce the violent effects observed. As Prof. Willard pointed out many years ago, each of these wells doubtless taps a subterranean reservoir of air, probably filling the interstices of sand or gravel beds. When the pressure of the external air is diminished some of this imprisoned air escapes, and the greater the fall of the barometer the greater the force with which the air is expelled. The fact that the majority of deep wells, closed at the top except for one or more small openings, do not exhibit the phenomena of blowing and sucking is, therefore, explained by the fact that they are not able to draw upon any considerable body of imprisoned air besides that contained in the well.

A serious result of the sucking process is often observed in winter. During the occurrence of high barometric pressure and its usual accompaniment, low temperature, a quantity of cold air is drawn into the well, and the water freezes, even at a depth of 100 feet or more below the surface of the ground.

The foregoing simple explanation of blowing and sucking wells does not apply to all cases. Fluctuations of water-level may doubtless give rise to similar phenomena. Suppose, for example, that a heavy fall of rain causes a general rise of the water-table in a water-bearing stratum of large area lying beneath an impervious stratum, the latter being perforated at only a few points by wells. The air imprisoned above an extensive sheet of water will thus be forced through a few small openings, each of which will be the source of a violent air current.

Fluctuations in the temperature of the outside air may also play a part in these phenomena. It is well known that many caverns, communicating with the outer air by small openings, blow in summer and suck in winter: the air within maintaining a nearly uniform temperature while that without varies with the season. According to Prof. Barbour, many observers notice a diurnal reversal of the air current in wells, corresponding to the diurnal period of the temperature.

Lastly, wells occur in which there is a continuous indraft, or a continuous outdraft. Two examples of the former exist in Georgia, and were described a few years ago by Prof. S. W. McCallie. In these cases, the air currents are entirely independent of atmospheric pressure, and are due to the friction of the air of a rapidly flowing subterranean stream of water. Prof. McCallie compares the action of such a stream to that of Richard's water air blast, found in many laboratories. The well forms the inlet for the air, and the rapid stream in the subterranean channel, into which the well opens, completes the conditions necessary for an ingoing air blast. As the air is constantly being drawn in at this point, it must escape constantly at some other point; if the latter happened to coincide in position with a well, we should have a well blowing constantly, without regard to the barometric pressure.

CLEANING AIR COMPRESSOR CYLINDERS

For cleaning air-compressor cylinders I tap a ½-in. hole in the suction line near the cylinder and screw in ½-in. pipe. Running vertically from this is a 2-in. pipe. 18 in. long; on top of it I put a screw cap and on the ½-in. line I put a globe valve.

Once a week I use 2 gal. of hot water in which has been sliced a cake of soap. I stir it thoroughly until all of the soap dissolves; then gradually pour in the top of the pipe, through a screened funnel, using about a cupful at a time. After using about three-quarters of the suds, I pour in one-half a cup of oil, and wash out with the balance of the suds. The oil is then put in at the suction inlet, so as to lubricate both upper and lower parts of the cylinder; when oiling with lubricators the oil does not get to the bottom of the cylinders.

Where there are two cylinders, of course the piping is also attached to the low-pressure one.—A. P. Shaw, in *Power*.

Dr. Walter O. Snelling, consulting chemist of the Bureau of Mines and of the Panama Canal Commission, now doing laboratory work in Washington, has developed a liquid gas of which a little steel bottle will carry enough to light a house for a month. Snelling puts 2,000 feet of gas into a steel container four feet high and six inches in diameter.

The Carnegie Steel Company is reconstructing an open-hearth furnace for the use of tar as fuel. The tar is placed in tanks and pumped under the furnace, then heated and blown into it by compressed air. The heat, it is stated, is as intense as that from oil, gas, or other fuel, and is relatively cheap.

COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC

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AIR AS A SHIP SAVER

The Managing Editor of Compressed Air Magazine has made a valuable contribution to the subject of safety of passengers in ships in the article which he publishes in this issue entitled "Air to Keep the Water Out." The loss of the Titanic has dealt a death blow to our confidence in the reliability of the bulkhead, except under certain conditions which do not, and cannot, always obtain. Mr. Richards maintains that the unsinkable ship is unthinkable without the aid of air, and in this he simply calls attention to well known physical laws which might easily be applied to the safety of ships.

If we take an empty tumbler, turn it upside down and press it in a bucket of water we confine a certain volume of air within the tumbler, and so long as this air is so confined it keeps the water out. As the tumbler is pressed deeper into the water the air space becomes smaller, because the water pressure compresses the air. Now it is not a difficult matter to conceive that the hull of a ship might represent a tumbler upside down in the water. The upper deck of the ship being sealed and air tight would prevent the air from being displaced by water, and so long as equilibrium is maintained and the decks are air tight one might imagine the entire bottom of the ship below the water line torn away and yet the ship would remain afloat.

The whole problem seems a very simple one and its practicability is hardly a matter of dispute. Where the size or shape of the vessel is such that free air alone cannot be depended upon it is an easy matter to provide a compressor to force air under the decks and in this way confine the water to certain levels. Such a distribution of compressed air might be effected and controlled by valves so that the equilibrium of the boat would be maintained through admission of more or less air or water into certain compartments on either side or end of the ship.

The whole subject, in its details, is one which belongs to the shipbuilder. In war vessels the problem would seem less difficult, so far as construction is concerned, than in merchant vessels, because in the latter case it will be necessary to arrange so that the hatches and other passages leading to the decks will be so constructed as not to interfere with the air-tightness of the decks and compartments.

In building the tunnels under the rivers about New York compressed air was used for precisely this purpose; that is, to keep the water out; it is common practice in caisson construction which is going on about us daily when laying foundations for buildings. Furthermore, the plan has been successfully applied in raising ships, for it is easily seen that if the water within the hull of a ship is replaced by confined air the ship will float. A thing that floats does so because it is lighter than the volume of water which it displaces.

On the ocean, as elsewhere, things are continually occurring which never happened before, and all contingencies cannot be anticipated or provided for, but air tight compartments and air compressors certainly offer additional elements of safety. The City of Paris, which the writer speaks of, had a narrow escape, but it would seem to be practically certain that if, when her engine room was flooded and she lay as inert as a sawlog, air could have been applied at a pressure not above 10 or 12 pounds the water would have been driven down and out, the leak could have been temporarily stopped from the inside, and one-half of her propelling apparatus could have been put at work at once to bring her to port. There are so many other cases in which the air could be made to keep out or to drive out the water and insure safety that its aid should no longer be ignored. W. L. S.

COMBUSTION IN COMPRESSED AIR

A correspondent writes:

"I noticed that the low pressure air pipe lines and the receiver were smoking. The compressed air for these lines is furnished by three compressors. I remarked to the mechanic in charge that he was operating his compressor under dangerous conditions and that I thought he should shut down and look after leaky discharge valves. He told me that he would have to keep going for a little while longer. I then went to dinner, and we returned to the mine. We found the compressor shut down, the mechanics repairing and replacing some defective discharge valves, and a man from the mine laid out on a stretcher. I at first thought he was hurt; I later heard the surmise that he had been overcome by the heat. I went over and looked at him, and combining the overheated compressors with his appearance, diagnosed his case, with the assistance of a doctor, as carbon monoxide poisoning.

"A little later when the man could talk he informed us that he was a scraper and that the air coming from the machine had been very bad for some time. Other parts of the mine were also made unpleasant by the exhaust of the air from the machines, but so far as I was able to learn no other men were seriously inconvenienced, probably due to the fact that there was sufficient ventilation.

"Another interesting feature in connection with this experience was the melting off of the ends of some wrought iron clamps which had been used to stop a leak in the low pressure pipe line. This leak had been stopped with clamps and packing, the intense heat detroyed the packing, and the heated carbon monoxide coming in contact with additional air on the outside of the pipe line, burned, producing sufficient heat to melt the ends of the wrought iron clamps as previously mentioned."

Here is an incident which probably occurs often in old compressed air plants; that is, places where the air compressors have been used for some time, the inner parts and passages becoming more or less clogged with oil and carbon deposit. After feeding oil into an air line for several years it is very natural that in the interior of the receiver and the pipes and passages there should be a black carbon inflammable mixture, and as soon as the temperature is allowed to get high enough in the air line some of this mixture at least will burn, because there is plenty of fuel burning capacity in compressed air. The excess of oxygen simply needs carbon and heat to produce active combustion.

There are several ways by which a temperature increase might be effected,—one of them is where a discharge valve may become clogged, thus admitting the warm compressed air into the cylinder to be re-compressed. There are chances that particles of grit or dust may be drawn in with the air and through contact with the moving parts in the interior a spark might be produced. Furthermore it is quite possible that the water cooling devices may be limited in their effects, the water may be warmed or the passages choked and the simple heat of compression may be sufficient to raise the temperature to the point where some of these interior vapors will inflame.

W. L. S.

AIR COMPRESSOR LUBRICATION

The lubrication of air compressors and of pneumatic tools is the most important matter connected with their operation. The lubrication of the latter is necessary to keep them working satisfactorily and to prevent under wear; but in the case of the compressor the matter of proper lubrication is vastly more important. Explosions in compressed air plants are still all too frequent, and incorrect lubrication practice seems to be almost entirely to blame.

A common fault is to use too much oil, and oil that has too low a flash point. An air compressor does not require as much oil as a steam cylinder, and it is well to limit the use of oil to a minimum. Oil tends to cause the valves to stick and thereby necessitates frequent cleaning. If kerosene is used to remove the deposit the valves must be taken out, although engineers have been known to introduce kerosene through the air inlet valves for this purpose. Kerosene will clean the valves, but it is also equally effective in producing explosions.

The sanest method is to lubricate air compressor cylinders with soapy water and flake graphite. Such a mixture provides economical, efficient and safe lubrication and keeps the valves clean. A little oil should be introduced when shutting down the compressor, to prevent any tendency of the soap suds to cause rusting. By this method all dangers attending the use of oil are avoided.

Flake graphite has a strong tendency to attach itself to metal surfaces, and, when thoroughly worked into the inequalities of such surfaces, imparts a superficial glaze or veneering of great smoothness, high polish and endurance that prevents actual contact, metal to metal, and makes it possible for relatively small quantities of fluid lubricants to provide a safe and sufficient film or lubricating layer.

Flake graphite is an inert mineral; its normal smoothness is quite unaffected by any degree of heat attainable in the air compressor cylinder. Under no condition can it be volatilized, or baked into a hard or gummy mass to interfere with the free action of the valves. On the contrary, its presence upon working surfaces is a guarantee of smooth operation. One of the best booklets is "Air Compressor Lubrication," published by the Joseph Dixon Crucible Co., Jersey City, N. J. Everyone in any way interested in the operation of compressors should read this booklet for it contains information worth having. Free copies may be obtained from the above company upon request.

NEW BOOK

The Subways and Tunnels of New York, Methods and Costs with an Appendix on Tunneling Machinery and Tables of Engineering Data, by Gilbert H. Gilbert, Lucius I. Wightman and W. L. Saunders. New York, John Wiley & Sons. 386 pages 6 by 9 in., about 100 illustrations, mostly half tones, in the text and 20 folded insets. Price $4.00.

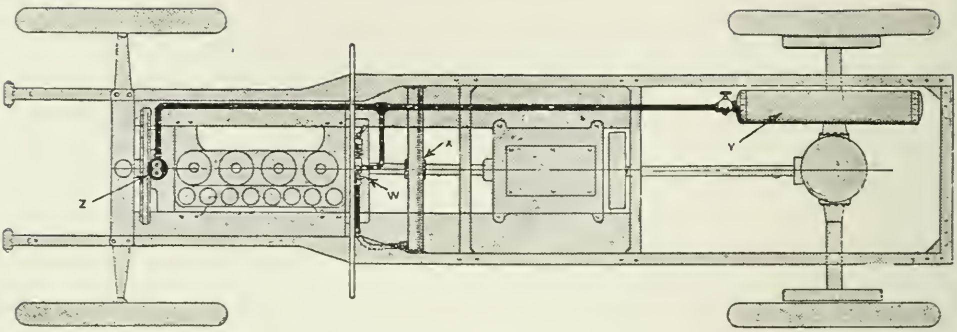
A complete account of the tunnels and subways of New York can never be written; the work is too vast and various, involving in the aggregate a cost greater than that of the Panama Canal, with some of the most difficult practical tasks ever encountered and carried to successful completion by the world's great engineers. The book is filled with facts and data and detailed descriptions of the various types of work and the means and methods of accomplishment. Compressed air as the most responsible agent employed is given its appropriate prominence and the appendix is mostly a compendium of general compressed air data.

A COMPRESSED AIR AUTO STARTER

The cuts here reproduced from The Autocar, London, illustrate a starting device which is used upon Autocars built by the Enfield Autocar Company, Limited, Sparbrook, Birmingham, England.

A responsible part of the apparatus is a small air compressor driven from the crank-shaft at the forward end of the engine. This charges a tank up to a pressure of about 150 lbs., the clearance space of the compressor being so adjusted that when this pressure is exceeded no air will be delivered.

Instead of leading the air from the storage tank to the main engine cylinders through a distributor and a special valve gear, the engine is revolved through the medium of a



PLAN OF AUTO WITH AIR STARTER.

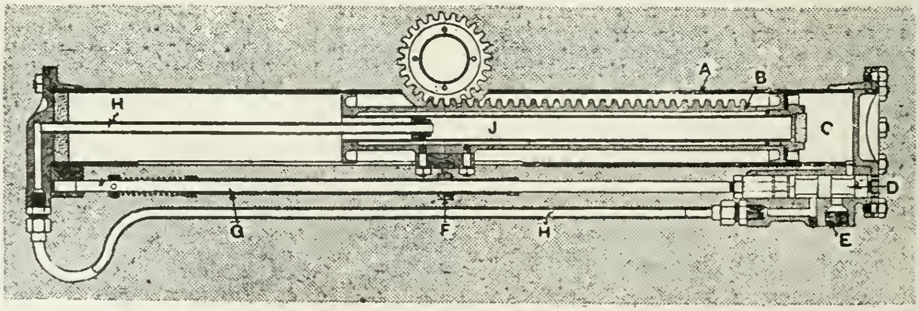
toothed wheel mounted on a stout free-wheel on the shaft which joins the clutch to the gear box. Mounted across the frame, of which it practically forms a part, is the apparatus shown in the diagram. Here A is a cylinder containing a long piston B, on the trunk of which a rack is cut. If now air be admitted to the space C the piston will be driven to the left, the rack will cause the gear pinions to revolve, and this in turn will spin the engine, the free-wheel allowing the crank-shaft to run on directly the first explosion takes place. Actually the piston normally is further to the right than shown, so that the end of the rack clears the pinion, and then, of course, even the free-wheel is not in use, the pinion merely revolving loosely. The first operation is to depress a small pedal which sets the admission valve D, and then a tap on the dashboard is turned admitting air at E. The piston now travels down its stroke, and, near the end, the striker F touches a collar on the valve rod G, so moving the valve, allowing the used air to escape, and admitting more air through the pipe H to the inside J of the main piston. As the pipe H ends in a kind of piston this action causes the main piston to be blown back into place ready for the next start.

Naturally the capacity of the storage tank is sufficient to enable many starts to be made on one charge of air, although, in an ordinary way, one operation is enough. The pressure of the air is great enough to spin the engine sharply, and if a backfire should happen the only effect would be to drive the starter piston back against its air cushion and no harm would be done.

AIR DRIVEN STEAN PUMPS WORK AFTER LONG SUBMERGENCE

BY CHARLES MENTZEL.

At the Cordova mines in Ontario there is a 400-ft. shaft in which the pumps were drowned and remained submerged for eight years. A few weeks ago it was decided to unwater the shaft which makes about 15,000 gal. per hour. On the 200-ft. level there is a 7½x4½x10-in. duplex pump of the Worthington type, which was built by the Northey Pump Co., of Toronto—no longer in business. The column pipes and air lines had not been touched in eight years and the water



MECHANISM OF AIR STARTER.

was within 20 ft. of the collar of the shaft. On giving it air, the pump immediately started and pumped 96 hr., then stopped. On reaching the 200-ft. level with a sinking-pump, it was found that a setscrew in a rocker-arm had slipped. After fixing this the pump worked as well as ever.

On the 300-ft. level there are two 5¼x3½-x6-in. duplex pumps of the same type, lifting to a sump at the 200-ft. level; both discharges being connected to a 5-in. column pipe. Upon turning on the air at the 200-ft. level these pumps immediately began to work and are still pumping after a continuous work for a week. On the 400-ft. level there is another pump lifting to the 300-ft. level and no doubt is entertained that on reaching the 300-ft. level and turning on the power, this pump will also do its duty. Under the conditions this work is remarkable.

ARTIFICIAL SNOW IN SKIN TREATMENT

Carbon dioxid is one of the few gases that are easily converted into a liquid by the mere application of extreme pressure, at ordinary temperatures. The liquid carbon dioxid may now be purchased in most large cities, the material being delivered in strong metal flasks. For the treatment of various skin diseases a snow or solid rod of this substance has been successfully employed. On opening wide the valve of the tank, the liquid escapes rapidly into the air; as it evaporates, the temperature is greatly reduced—reaching as low as 110 degress below zero, Fahrenheit. The result of this rapid cooling is that some of the escaping liquid about the valve is frozen to a snow. If the stream of escaping liquid is directed into a bag made of chamois skin, it is possible to obtain a mass of snow about the size of a hen's egg in from five to ten seconds. The snow is shaped into cylindrical rods or "pencils" by being pressed into wooden molds.

The application of the tip of one of these rods to the skin results in a freezing effect; the extent of the area acted upon, or the depth to which it reaches, may be completely controlled by the surgeon according to the needs of each case, since the pressure and the movements of the pencil determine how much is "frozen." The application lasts from one second to about a minute, according to the amount of tissue that is to be frozen. By this means many skin eruptions and blemishes have been successfully treated.

AUTOGENE

The "Autogene" air-gas system, invented by P. C. Booty, of Perth, Western Australia, is a device for manufacturing gas from gasoline and air—98 per cent. air and 2 per cent. gasoline vapor. The apparatus is simple, consisting mainly of a patent valve and carburetor by means of which gas of uniform quality is automatically supplied to the service irrespective of the fluctuation of the load. No more gas is generated than is needed for immediate consumption. Connected to the valve is an air pump of simple form surmounted by a gasoline tank and air holder. The pump may be operated by a weight-driven, electric, or water motor, or by a hot-air motor supplied with gas from the system. The gas produced is not poisonous, and as there is no storage of gas the insurance companies do not charge extra premiums. The mixture is used for lighting, heating and power purposes. The light is said to be white and of a very good quality, and there is a total absence of smoke or smell. As the system supplies its own air there is no depletion of oxygen in the room where the gas is being consumed. The outfit is capable of producing 1,200 cubic feet of gas for each gallon of gasoline used. The system seems suited for a variety of purposes, such as laundry work, mining, metallurgy, laboratory work, heating, and cooking. It makes it possible for a family living far from a gas works to enjoy the advantages of a gas ring, griller, gas stove, bath heater, etc.—*Consular Reports.*

NOTES

In the cement work of the Woolworth Building now being erected in New York as much as 417 cu. ft. have been deposited with a double nozzle cement gun in an 8-hour day, despite some delays in moving the machine about the building.

Compressed air is used according to the report of the Copper Queen, at the rate of 0.0102 cu. ft. per min. per annual ton of ore produced. If this is the maximum amount required it checks well with the rated capacity of the compressors required at the Goldfield Consolidated, Goldfield, Nev., where two compressors are used with a rated capacity of 1,500 cu. ft. each per min. Based on an output of 330,000 tons annually, this is approximately 0.0091 cu. ft. of air per minute for an annual ton.

It is stated in *The Lancet* that 77,000 tons of soot fell in London last year. This came from the chimneys of 6,000,000 people and contained 6,000 tons of ammonia, 8,000 tons of sulphates, 3,000 tons of chlorides, and carbon, tar, tin and lead.

Preheating air for internal combustion engines was recently discussed in Le Genie Civil by A. Nougier. The author recommended passing the air over tubes in a preheater taking much the same form as a tubular boiler, the exhaust products from the engine cylinder passing in the reverse direction through the tubes. He claimed that it is possible to construct a heater capable of preheating the air to 175 deg. F., at no load without overheating the air at full load. Such a heater for a 200-hp. motor would be 23 in. in diameter and contain 100 tubes about 40 in. long.

New works are being erected for the manufacture of oxygen at Bromborough Port, three miles above Liverpool, on the opposite shore of the Mersey River, and they are expected to be in operation by October of the present year. The plant is designed to produce 200,000,000 cubic feet of oxygen and hydrógen a year. Two gas engines, each of 1,750 horsepower, direct-coupled to continuous current generators, with Mond gas and recovery plant, will furnish the power. It is expected that oxygen will be sold as low as $1.21 per 1,000 cubic feet direct from holders and $4.86 in cylinders, and that the purity will be increased to 99½ per cent.

From one ton of ordinary gas coal may be produced 1,500 pounds of coke, 20 gallons of ammonia water and 140 pounds of coal tar. By distillation the coal tar will yield 69.6 pounds of pitch, 17 pounds of creosote, 14 pounds of heavy oils, 9.5 pounds of naptha yellow, 6.3 pounds of naphthaline, 4.75 pounds napthol, 2.25 pounds alazarin, 2.4 pounds solvent naptha, 1.5 pounds phenol, 1.2 pounds aurine, 1.1 pounds benzine, 1.1 pounds analine, 0.77 of a pound toludine, 0.46 of a pound of anthracine and 0.9 of a pound toluene. From the latter is obtained the substance known as saccharine, which is 230 times as sweet as the best cane sugar.

An enterprising mechanic of California has invented a unique device in the shape of a nickle-in-the-slot machine which will supply bicycle and motorcycle owners with compressed air to inflate the tires quickly and at a moderate cost. The machines are placed on telephone poles along the thoroughfares mostly frequented by cycle riders, and they are netting their owner a handsome income and providing a great convenience to the people who have use for compressed air. The reservoirs are built of iron and not larger than good-sized mail boxes.

"A new method for discovering deposits of ores, coal and oil has been found by Prof. Jakob Koenigsberger. After taking tests in many boreholes with the most varied local surroundings, he found that the rate at which the earth's crust grows warmer at lower levels is far from uniform. He gives the average rate at about 64 feet for one degree Fahrenheit, but near a sea coast it requires as much as 200 feet in some cases to get one degree higher temperature. It was found, however, that over coal deposits the rate is only 47 to 55 feet. Oil heats the earth still more rapidly, causing a gain of one degree for every 15 or 20 feet. It is believed that Prof. Koenigsberger's investigations will prove of great use in prospecting for mineral and oil deposits.

The scheme for tunneling the Behring Straits and thus linking up the railway systems of Siberia and North America is again being revived, representatives of an American syndicate being at present in Europe for the purpose. The scheme involves the construction of a forty-mile tunnel beneath the Straits, and the building of new railways both in Siberia and North-West America to reach the approach stations on each side, and would enable passengers from any European capital to travel to New York and the principal cities of the United States and Canada by train journey throughout. It is proposed to sink shafts from islands situated midway in the Behring Straits, thus enabling construction to be begun simultaneously from various points, and these shafts would subsequently be employed for ventilating the tunnel.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 2.

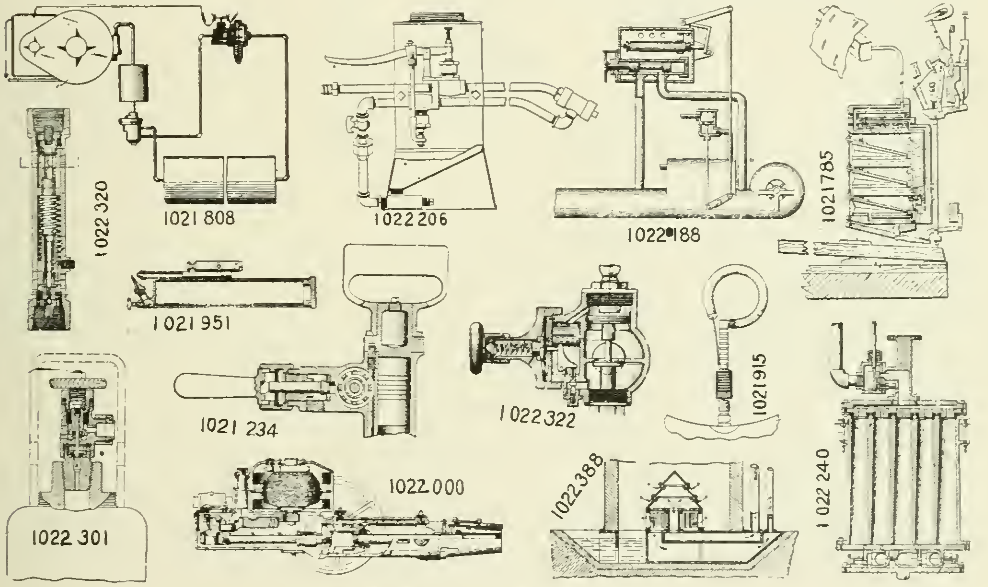
1,021,785. PNEUMATIC MUSICAL INSTRUMENT. Albert Krell, Connersville, Ind.

1,021,808. UNLOADING DEVICE FOR PUMPS. Walter V. Turner, Edgewood, Pa.

1. The combination with a pump, a storage reservoir for the fluid compressed by the pump, a governor for said pump and a receptacle intermediate the pump and reservoir into which the pump is adapted to compress fluid, of a valve device operated by fluid under pressure controlled by the governor for controlling an exhaust port from said receptacle.

1,021,915. AIR-GAGE. Joseph A. Buttress, Los Angeles, Cal.

1,021,951. ATOMIZING APPARATUS. Walter J. Smart, New York, N. Y.



Pneumatic Patents, April 2.

1. In an air brush, the combination with a cylindrical reservoir having a free and clear interior and constituting the handle of the device, of an air tube mounted on one side of the reservoir and extending beyond one end thereof, a nozzle mounted on the said tube and longitudinally adjustable thereon, an extension from the other side of the said cylinder end provided with a chamber, there being a port from the cylinder to such chamber, a needle valve for controlling the port, a nozzle connection on such extension, a nozzle on the connection adjustable toward and from the air nozzle.

1,022,000. ELECTROPNEUMATIC TOOL. Alexander Palmros, Fairmount, W. Va.

1,022,188. COMPENSATING SYSTEM OF TEMPERATURE CONTROL. Harry G. Geissinger, New York, N. Y.

1. A temperature controlling apparatus including hot and cold air ducts, a mixed air conduit, a mixing damper arranged to close or partially close either of the said ducts for varying the relative volumes of the air delivered to the mixed air conduit, a thermostat having a casing, mechanism controlled by the thermostat for actuating the damper, and a duct extending from the thermostat casing to the mixed air conduit.

1,022,206. SPRAYING-MACHINE. William O. Quest, Pittsburgh, Pa.

1. In a spraying machine, the combination of a portable tank, a spraying head comprising a casing inclosing a chamber and having a spraying nozzle, a pipe for connecting the chamber and the interior of the tank, and a fluid pressure connection to said chamber, said pipe and said connection being attached to the side of a tank substantially at its vertical center and serving as carrying handles therefor.

1,022,240. MOLDING APPARATUS. Maddra J. Hewlett, Kewanee, Ill.

1,022,284. LUBRICATING MECHANISM. Daniel Shaw Waugh, Denver, Colo.

1,022,301. CONTAINER OR CYLINDER FOR COMPRESSED OR LIQUEFIED GAS. Robert Hunter Campbell, Edmonton, England.

1,022,322. PRESSURE-REDUCING DEVICE. Thomas H. Manchester, Chicago, Ill.

1,022,388. BLOWER FOR GAS-PRODUCERS. Alfred Barker Duff, Pittsburgh, Pa.

1,022,330. FLUID-PRESSURE REGULATOR. Joseph D. Ramsey, Boston, Mass.

APRIL 9.

1,022,407. AUXILIARY CONTROLLER. Robert Cramer, Milwaukee, Wis.

1,022,416. RECOVERING VOLATILE LIQUIDS. Charles Harrison, William Bate, and Walter G. Perks, Hayle, England.

1. A process for the recovery of small percentages of vapor of volatile liquid diffused through a large bulk of air, which comprises causing the air current to pass upward through a series of separate and independent saturators, through which a chemically indifferent liquid descends from one to another in a continuous undisturbed flow, whereby the volatile vapor is diffused through the absorbent liquid, and finally recovering the dissolved volatile liquid therefrom by distillation.

1,022,453. AIR-BRAKE-HOSE COUPLING. Oliver P. Wilhelm, Michigan City, Ind.

1,022,499. PNEUMATIC CLEANER. Theodore O. Osterholm, Worcester, Mass.

1,022,602. APPARATUS FOR REGENERATING AIR. George von Scharpringer, Vienna, Austria-Hungary.

1,022,805. APPARATUS FOR FEEDING FINE FUEL. John A. Welton, Canal Dover, Ohio.

1,022,837. PNEUMATIC HAMMER. Charles B. French, Kingston, Pa.

1,022,851. AIR COUPLING-VALVE. Fred Knack, Cleveland, Ohio.

1,022,955. APPARATUS FOR TESTING AIR. Walter Stuart Leech, Brooten, Minn.

1,022,968. APPARATUS FOR AERATING LIQUIDS. Ludwig Neumayer, Strassburg, Germany.

1,023,041. COMPRESSED-AIR MACHINE. Jacob Gilmore Saurenmann, Canadian, Tex.

1,023,065. AIR-PROPELLER. Jesey H. Buchanan, Midway, Tex.

1,023,066. PRESSING-MACHINE. Henry H. Burns, Battle Creek, Mich.

1,023,090. PNEUMATIC CLEANSING APPARATUS. Albert E. Moorhead, San Francisco, Cal.

13,402. (Reissue). ENGINEER'S BRAKE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,023,359. INDUCED SUCTION FOR VACUUM-CLEANERS. James Birrell and William Birrell, Seattle, Wash.

1,023,408. CENTRIGUGAL ELASTIC-FLUID COMPRESSOR. Karl Alquist, Schenectady, N. Y.

1,023,565. AIR-PRESSURE-CREATING DEVICE FOR GASOLENE-SUPPLY TO ENGINES, &c. William P. Herbert, Philadelphia, Pa.

1,023,583. INJECTOR ATTACHMENT FOR AIR OR STEAM PUMPS. Frank S. Morgan, Nevada City, Cal.

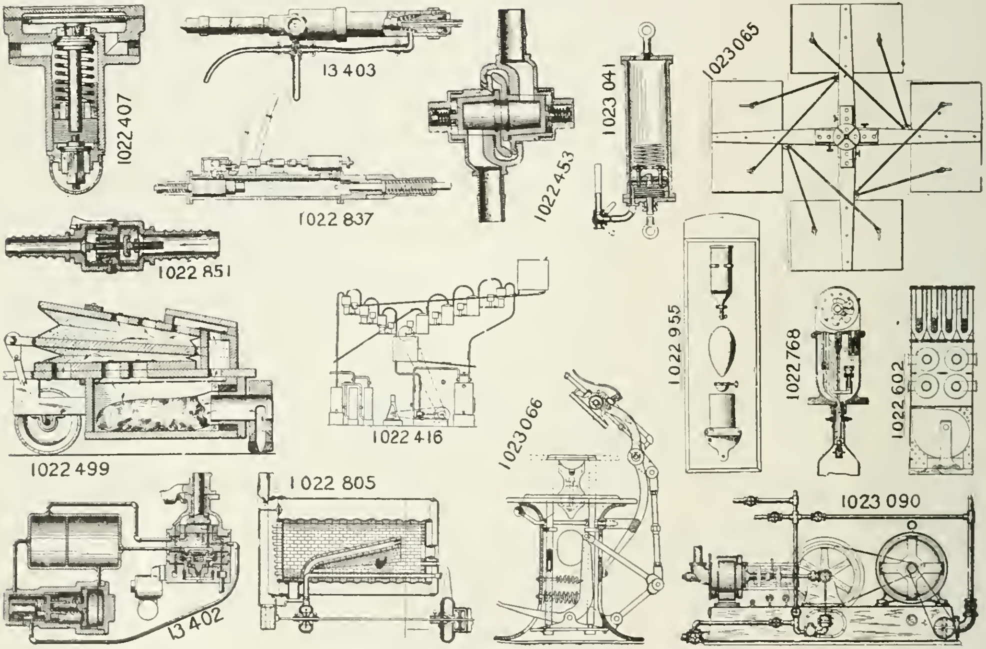
1,023,594. DUST-COLLECTOR FOR DRILLS. William Prellwitz, Easton, Pa.

1,023,613. PNEUMATIC PIANO. William G. Betz, Steger, Ill.

1,023,685. COMPRESSOR-PUMP. William F. Ruwell, Philadelphia, Pa.

APRIL 23.

1,023,790. SLACK-ADJUSTER FOR BRAKES. Julius J. Acker, Horton, Kans.



Pneumatic Patents, April 9.

13,403. (Reissue). DRILL-HOLE-CLEANING ATTACHMENT FOR HAMMER-DRILLS. Daniel S. Waugh, Denver, Colo.

APRIL 16.

1,023,132. INDICATOR FOR INDICATING THE ASCENDING AND DESCENDING MOVEMENTS OF AERIAL VEHICLES. Levitt Luzern Custer, Dayton, Ohio.

2. In a device of the type specified, a casing providing an air chamber, a tube extending from an opening in one side of said chamber and communicating with the atmosphere on the other side, said tube being enlarged at its ends, and a globule in said tube that the movement of which indicates the flow of air therethrough, said tube being depressed near the middle portion and gradually raised from said middle portion to its ends.

1,023,146. AIR-PRESSURE REGULATOR FOR FORCE-PUMPS. Frank J. Gile, Lawrence, Mass.

1,023,260. AIR-TREATING APPARATUS. Daniel M. Luehrs, Toledo, Ohio, and William S. Conant, Detroit, Mich.

1,023,820. AIR-COMPRESSOR. Wilburn N. Dennison, Merchantville, N. J.

1,023,825. CAISSON. Oliver Cromwell Edwards, Jr., Troy, N. Y.

1,023,868. PNEUMATIC CUSHION FOR VEHICLES. Abraham J. Oling, Chicago, Ill.

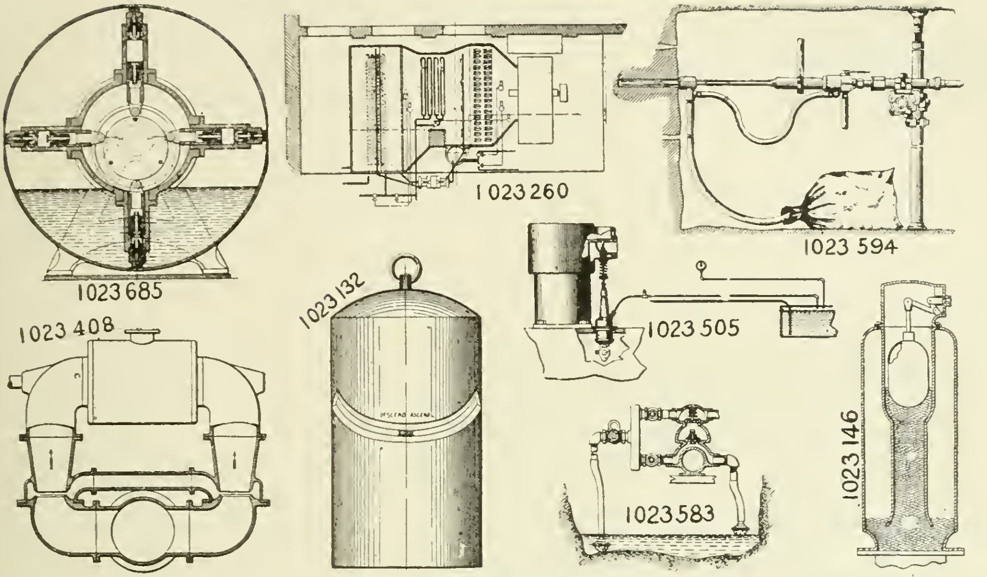
1,023,899. DRILL-HOLE-CLEANING ATTACHMENT FOR HAMMER-DRILLS. Daniel S. Waugh, Denver, Colo.

1,023,907. MECHANICAL AIR DEVICE FOR EXPELLING WATER OR OTHER LIQUIDS FROM THE HEADS OF TORPEDOES TO AID IN THE RECOVERY THEREOF AFTER FIRING. Kenneth Whiting and James B. Howell, U. S. Navy.

1,024,041. PNEUMATIC CLEANER. John C. Tauber, Erie, Pa.

1,024,073. APPARATUS FOR DRYING SUGAR. William H. Hannam and Warren E. Murray, San Francisco, Cal.

1. An apparatus for the described purpose, the same comprising a chamber or receptacle for heated air, and endless conveyor consisting of a plurality of hinged open frames working over said



Pneumatic Patents, April 16.

receptacle, a feed hopper arranged above said conveyer for supplying sugar to the hinged frames thereof as brought into horizontal alinement, and means for supplying *heated air under pressure* within the mentioned receptacle.

1,024,267. VACUUM DUST-SUCKER. Gustav Lindenberg, Barmen, Germany.

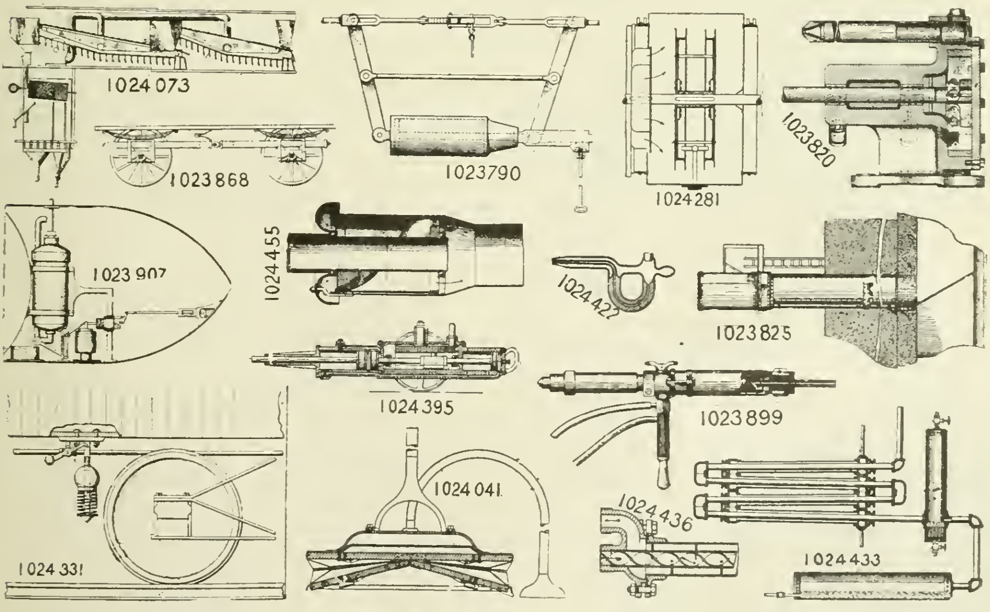
1,024,281. DEVICE FOR SPRAYING LIQUIDS AND MOISTENING AIR. Carl Heinrich Prott, Rheydt, Germany.

1,024,331. SAFETY AIR-BRAKE APPLIANCE FOR RAILWAY-CARS. John Alfred Gyllenberg, Baker, Oreg.

1,024,395. FLUID-OPERATED TOOL. John W. Canty, Florence, Colo.

1,024,422. MEDICAL SPRAYING-SYRINGE. Moritz Saenger, Magdeburg, Germany.

A medical spraying syringe comprising in combination a U shaped capillary tube for the liquid to be sprayed, a horizontal branch at the front



Pneumatic Patents, April 23.

end of said capillary tube, a tube for the *air under pressure* arranged above said capillary tube and surrounding the horizontal front end of the same, and an air inlet at the rear end of said air tube, substantially as described and shown and for the purpose set forth.

1,024,433. ACCUMULATOR AND SEPARATOR ATTACHMENT FOR GAS-LIQUEFYING APPARATUS. Fred C. Bell, Alameda, Cal.

1,024,436. APPARATUS FOR CHANGING THE TEMPERATURE OF LIQUIDS. Paul Joseph Cartault, Paris, France.

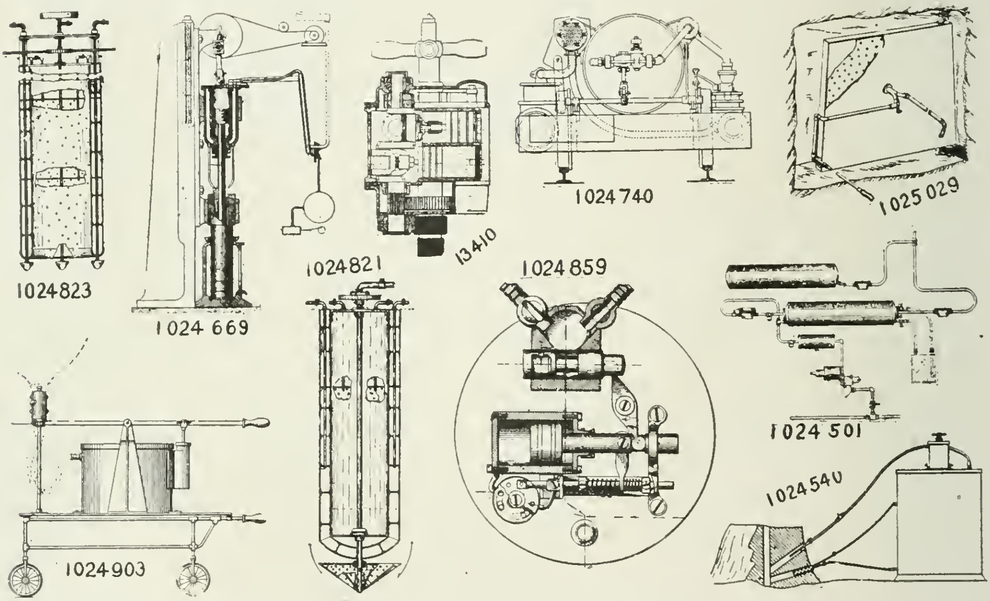
1,024,455. PNEUMATIC COTTON-PICKER. Eugene Murray, Washington, D. C.

1. A nozzle for pneumatic cotton picking apparatus comprising a revolving cylinder and a revolving picking tube.

APRIL 30.

1,024,501. LIGHTING APPARATUS. Robert M. Dixon, East Orange, and George E. Hulse, Jersey City, N. J.

1. In apparatus of the class described, in combination, a car having mounted thereon an air-braking system, a lighting system and a carbureter, connection between said air-braking system and said carbureter and between sair carbureter and said lighting system, whereby said carbureter is supplied from said braking system and supplies said lighting system, means positoned in said first connection adapted to regulate the air supply in accordance with the temperature thereof, and means positioned in said second connection adapted to maintain substantially constant the pressure of the fluid passing therethrough.



Pneumatic Patents, April 30.

1,024,533. OZONIZER. Harve R. Stuart, Wilkinsburg, Pa., and Wilbur H. Thompson, Springfield, Mass.

1,024,540. METHOD OF DESTROYING STUMPS. Warren E. White, Spokane, Wash.

1. The process of burning tree-stumps which consists in making holes in the stump and a vent therefor, injecting into the stump, through one of the holes, burning liquid fuel and *air under pressure,* and injecting into the stump, through the other hole, an inflammable liquid.

1,024,574. DEVICE FOR THE FACILITATION OF THE EXCHANGE OF BORES IN ROCK-DRILLS. Frederik Christian Andreas Herstad, Finspang, Sweden.

1,024,669. PNEUMATIC PERCUSSIVE APPARATUS. Hans Charles Behr, Johannesburg, Transvaal.

1,024,740. COMPRESSED-AIR ENGINE. Daniel R. Murphy, Fredericktown, Pa.

1,024,763. AIR-COOLING APPARATUS FOR FRUIT. William C. Anderson, San Jose, Cal.

1,024,778. COMPRESSED - AIR ENGINE. Charles B. Hodges, Pittsburg, Pa.

1,024,821. CAISSON CONSTRUCTION. Edward Bignell, Lincoln, Nebr.

1,024,823. SELF-SINKING CAISSON. Edward Bignell, Lincoln, Nebr.

1,024,859. MILKING-MACHINE. Daniel Klein, Spokane, Wash., assignor to D. H. Burrell & Co., Little Falls.

1,024,887. APPARATUS FOR DRYING AIR. Albert Gaide, Chicago, Ill.

1. An apparatus for drying air comprising an inlet chamber; means for sprinkling said chamber with cool water; a main water outlet for said chamber located near the bottom thereof; a supplemental water outlet for said chamber located above said main water outlet; a tank arranged to receive the water from said main outlet; a valve for said main outlet; a float controlled by a level in said tank and arranged to operate said valve; a refrigerating chamber in communication with said inlet chamber; and means for passing air through said inlet and then through said refrigerating chamber, substantially as described.

1,024,903. MILKING DEVICE. Ellis Levay, Ennis, Tex.

1,025,029. APPARATUS FOR TUNNELING ROCK. Harvey F. Sutton, Salt Lake City, Utah.

1. Apparatus for tunneling rock, including a hollow head having a mixing chamber therein, said head having a working face formed with a plurality of minute aperatures, means for pivotally supporting the head close to the surface to be acted upon, means for directing fuel into the head, valves for controlling the passage of fuel through said means, and means for directing *air under pressure* into the head.

13,410. (Reissue). PNEUMATIC DRILL OR LIKE MACHINE. George Harry Hayes, Chicago, Ill.

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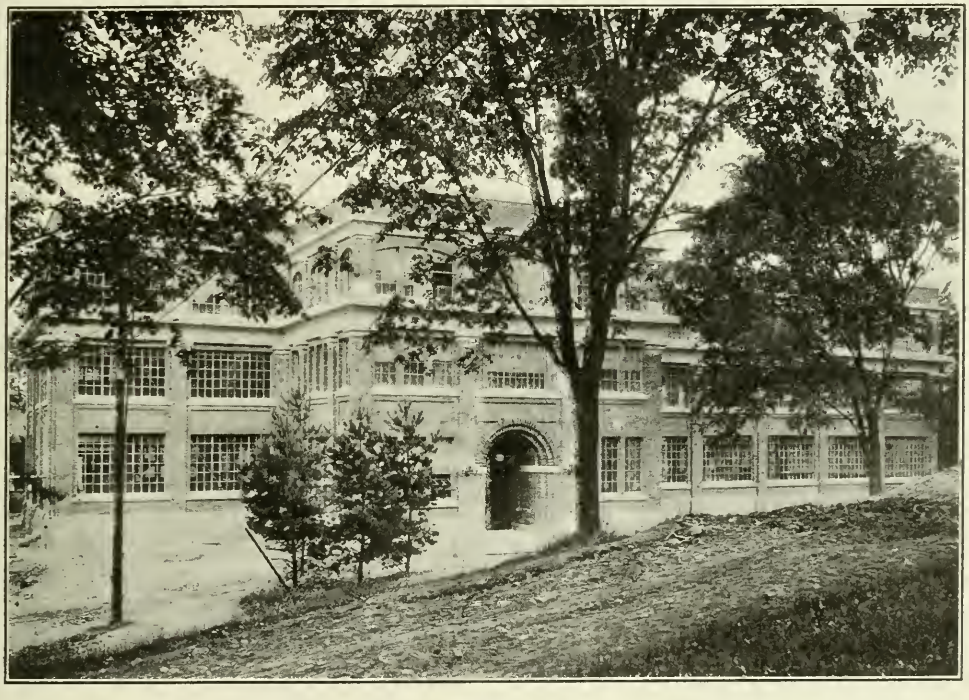
COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVII JULY, 1912 No. 7



RAND HALL, SIBLEY COLLEGE, CORNELL UNIVERSITY.

RAND MEMORIAL HALL

The building which we see here, Rand Memorial Hall, is the latest addition to the unique assemblage of noble structures which constitute the habitat of Cornell University. It is the gift of Mrs. O. R. Lang, the daughter of Jasper Raymond Rand, who, with his brother, Addison Crittenden Rand, founded the Rand Drill Company. It is a memorial to Mrs. Lang's father and uncle, and to her brother, Jasper Raymond Rand, Jr., later of the firm and a former student of Sibley College.

The gift of this building fitted perfectly into the general scheme of extension the planning of which has been compelled by the continuing increase in the number of Sibley College students. These plans call for four new buildings to be occupied respectively by the mechanical laboratory, the electrical laboratory, the forge and foundry and the machine and pattern shop. The first three of these buildings will stand on ground occupied in part by present structures, while this building, the last of the series but the first to materialize, has been erected upon ground previously unoccupied.

and its erection before the others are torn down will enable instruction to be carried on without interruption.

The building is 164 feet long and 50 feet wide, is divided into 11 bays, and has an attached wing 45x31 feet. The machine shop will occupy the ground floor and the patternshop the top floor, the middle floor being for growth; and it will be particularly useful as a temporary location for parts of other departments during the transitional period of reconstruction. The building is of modern factory type with large windows, but modified architecturally to conform with the surrounding buildings and with the character of the university buildings as a whole. It is not necessary to go into a detailed description here. It represents throughout the best of modern construction and equipment.

In the formal inauguration of the building the following order was followed, President Schurman presiding:

Singing "Alma Mater," by the audience.
Address by Mr. George Westinghouse.
Song, "Cornell," led by Glee Club Quartet.
Address by Mr. F. A. Halsey.
Presentation of Key to Rand Hall by Mrs. Lang.
Acceptance of same by President Schurman.
Presentation of Key by Dr. Schurman to Director Smith.
Director Smith's acceptance of same.

The address of Mr. Westinghouse was a large and masterful appreciation of the modern profession of engineering, and of the great work done by the founders of Cornell and of those who have carried and are carrying it along upon so high a plane. The concluding passage was as follows:

I cannot adequately touch upon the other distinction of this occasion, at it demands a facility of expression which I do not possess; but Mrs. Lang will believe me when I say that there is a quality conveyed with her most generous gift that will ever enshrine high regard and the utmost respect in the hearts of all Cornellians for herself and for those she has honored in the naming of Rand Hall, for it is a woman's tribute to an art absolutely dominated by man, and this unique and gracious feature will render it the more precious and stimulating to all concerned in administering or receiving education in Cornell University. Our expressions of gratitude to her include a full recognition and appreciation of the unusual as well as the very valuable and timely nature of her gift.

The principal part of Mr. Halsey's address appears on other pages of the present issue. Being one of the earlier alumni of Cornell and also later and for many years a business worker with the Rands he was perhaps better qualified than any other man living to bring the two together as he did in his reminiscences of both. He paid the highest possible tribute to the memory of the Rand brothers by simply telling the straight truth about then as he knew them.

Mrs. Lang for her part of the programme said:

My first visit to Cornell University was made nineteen years ago, and scarcely a year has passed without my returning here. For a number of years we spent the entire summer at our cottage on the west shore of Cayuga Lake, and I am afraid I tired out many a visitor by insisting upon showing them all the interesting things to be found on this campus. During all this time I have been familiar with the Sibley shops and with the work done in them. If I had been a man I would have been at work in them myself. (Great applause).

I have seen the college grow and outgrow the shops, and so it is a great satisfaction to me that the opportunity has offered for me to provide this new one. Now that the building is completed it is with great pleasure that I hand to the Honorable President of Cornell University the key of Rand Hall. (Long continued applause followed by three cheers for Mrs. Lang.)

A drill hole exceeding a mile in depth is being put down in Kanawha county, West Virginia, by the Edwards Oil Co. It is stated that the final depth of this hole will be limited only by the capacity of the drilling equipment.

Citizens from Port of Spain are scientifically planting a large cocoanut estate in Tobago. After the growth on the land is cut and burned stump pullers are used. The first machine bought in the United States worked so satisfactorily that more have been ordered. It may be supposed that they will learn later of our recent use of dynamite for this work.

CULTURE IN THE EDUCATON OF ENGINEERS*

At one of the meetings of the American Institute of Mining Engineers, held in the hall of the Sheffield Scientific School at New Haven, a discussion arose as to whether or not sufficient importance was given to cultural studies in our scientific schools. A diagram was exhibited showing graphically the relative proportion that culture bore to other studies in the various colleges. In some there was a wide distribution of cultural work, in others the proportion was small, and in a few cases it was shown that these studies were entirely omitted in the curriculum.

During recess, a group of students were discussing the subject; one of them, a senior, said, "I don't see why they should *learn* a person culture in a scientific school." This remark, made in my presence, so impressed me as a concrete example of neglect in true educational lines that it has been chosen as a text for what is to follow.

Education in its broadest sense is mental and moral training. High schools and colleges differ from common schools in that they aim at higher planes of mental and moral life. The small boy is taught by stuffing, as one puts saw-dust in a doll; this is because his mind has not grown to the stage when it can think for itself. Impressions are received and transfixed by memory: the process is one of mental photography: the moral code is learned by rote as though it were the multiplication table.

Not so with the older, the college student: his highest aim in education is to learn to think for himself. "If you are a student force yourself to think independently; if a teacher compel your youth to express their own minds" writes Dr. Osborn of Columbia; and again, "The lesson of Huxley's life and the result of my own experience is that productive thinking is the chief *means* as well as the chief *end* of education."

Now, what is productive thinking? Let me answer this question by giving you Huxley's definition of culture: "The pursuit of any art or science with the view of its improvement." The storage process is of paramount importance only when applied to elementary education. It is but the auxiliary of the scholar who has passed from the junior to the senior stage of student life, and who aims to do things in the world. The pursuit of facts is a mathematical study. We learn of things that exist as a result of divine and human creation: The earth is round and it is composed of land and water. Water is hydrogen and oxygen combined. The square of the hypothenuse of a right angle triangle is equal to the sum of the squares of the other two sides. How elementary are these facts! It is important that we should know them; but even a large volume of facts when stored in the human mind is powerless to add one cubit to progress. It is like putting a pair of legs on the Encyclopedia Britanica and expecting it to do something. Knowledge is power, but reason is power in action.

Mr. James Gayley of the U. S. Steel Corporation told me recently that the professor at Lafayette College who taught him how to think made so deep an impression upon him that it has lasted throughout his life. Mr. Gayley is distinguished for what he has done as a metallurgical engineer. His life has been one of productive thinking: he has pursued science with the view of its improvement. That teacher, Mr. Gayley said, once gave him a solution containing iron, and instead of instructing him how best to precipitate the metal he told him to try three or four ways of doing it and report which was best. This led directly to thought and reason and built up a master mind among engineers. We may still heed the voice of old Carlyle crying from the heathery hills of Duncore, "Produce! Produce! Were it but the pitifullest infinitesimal fraction of a product, produce it in God's name! 'Tis the utmost thou hast in thee: out with it, then."

Where among all the professions do we get the results that come through productive thinking as from engineering? The engineer is the architect of the world's progress. Transportation in railways and ships, in motor cars and aeroplanes, is the productive thinking of mechanical engineers woven into our industrial life. The men who did these things were students of science, not that they might be mere storehouses of knowledge; but that they might produce. Civil, electrical, chemical and mining engineering are fields which afford infinite opportunities for research and progress. If

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**Address by William L. Saunders, Sc. D., at the 38th Annual Commencement of the Colorado School of Mines, Golden, Colo., May the 24th, 1912.*

you men of the future do not rise to your chances in these lines it is not because the fields are not still open for cultivation and growth, but rather through your own inefficiency or perhaps your topheaviness.

"In vain our toil
We ought to blame the culture, not the soil."

Even Huxley feared that men might be overfed scientifically when he said: "An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that a Scientific College would turn out none but lop-sided men."

All this bears upon culture in its broadest sense. Productive thinking is the most important form of culture. It makes for power refinement, progress, knowledge, taste, civilization. The subject, you see, is a very broad one; the obligation upon you as students of science is equally broad. Take care that you be not "lop-sided men."

A graduate of the Colorado School of Mines, like all graduates of the higher institutions of learning, misses his opportunities and discredits his college if he does not carry throughout all his walks of life the imprint of the educated man. Noblesse oblige is a degree, and an obligation, which is uniformly conferred upon all college men.

To carry this obligation properly one should study culture in all its phases and in its broadest sense. Study it as an undergraduate and study it still harder and more fully through all your post graduate life. To this end let us accept and profit by that definition of culture given us by Mathew Arnold—"acquainting ourselves with the best that has been known and said in the world." A professor at Wellesley College defined culture to the students as "that which is left after all else learned at College is forgotten."

Virtue and moral training belong to cultural work in the education of engineers. It is a mistake to suppose that schools and colleges are places for mental training only. Physical exercise through athletics is just as much a part of one's college life nowadays as the study of mathematics; the one helps the other. Emerson said "Archery, cricket, gun and fishing rod, horse and boat, are all educators, liberalizers." To the engineer physical training is of value in order to fit him for out-door work. Moral training is of even greater importance. Locke has placed virtue first in defining the objects of education. Wisdom he puts next, and then good breeding; last of all learning. It is more the province of the teacher than of the student to safeguard and train the character by precept and example, for, after all, "the foundation of culture, as of character, is at last the moral sentiment. This is the fountain of power."

It is a common saying that manners make the man. Good manners afford us easy lures with which to win friends and facile weapons to conquer enemies. Manners adorn the gentleman and smooth the way of the educated man through the world. Manners are never born in men; but they are bred by association and study. Like oil on the journals of an engine they banish friction and promote efficiency. There are many reasons why we should be polite, but the best reason is because it pays; it costs nothing.

It is said of William, Earl of Nassau, that he won a subject from the King of Spain every time he put off his hat. So engaging were the manners of Charles James Fox that Napoleon said of him on the occasion of his visit to Paris in 1805, "Mr. Fox will always hold the first place in an assembly of the Tuileries." "My gentleman," said Emerson, "will out-pray saints in chapel, out-general veterans in the field, and outshine all courtesy in the hall. He is good company for pirates and good with academicians; so that it is useless to fortify yourself against him; he has the private entrance to all minds, and I could as easily exclude myself as him."

Good speech is a rule of manners. It always avoids exaggeration. Moderation in language and tone is the trade mark of good breeding, and good breeding is after all mainly a matter of self culture. Madame de Stael valued conversation above everything, and so engaging was she in that art, that a prominent lady of France said of her, "If I were Queen, I should command her to talk to me every day."

The man of education mixes with the right kind of people and reads good books. Books lead us into pleasant paths of culture and happiness. Read that you may avoid worry; read that too much hard thinking may not dull the edge of intelligence and sap the roots of memory; read that you may know what has been done in the world; read that you may acquire that power which comes from knowledge; read that you may learn to value the example of great men's lives; that through them you may know that the grave is not the goal of life. Montaigne had a passion for books and never travelled without them; he said that reading roused his reason and employed his judgment rather than his memory.

But of greater importance than good speech and reading, of higher value to the engineer than manners, is ability to write good English. Engineers are not given to public speaking; they pride themselves in being workers; they compare themselves with General Grant, who did things. It is very true that the engineering profession is one of practical work; but no one can hope to achieve prominence in this profession who cannot write good understandable English. An engineer may not talk, but he must make reports; he must write letters; he should draw specifications and plans. To do these things properly he must command and know how to use the tools of language. Lord Bacon tells us that "reading makes a full man, conversation a ready man, and writing an exact man." Engineering is an exact science; accuracy is the one column on which the whole structure is reared. To write clearly and accurately can hardly be called an accomplishment, it is really a necessity. No college course is complete, whether it be a classical, scientific, medical or law course, without a thorough training in English. No graduate is worthy to be called an educated man who does not speak and write good English. It lifts a man above the common; it makes him bigger than his business or profession; it trims the ship of knowledge, and puts oil on rough places; it makes the man.

Margaret Fuller said that the object of life is to grow, and James Freeman Clarke has written a lecture upon this subject, "Man's Duty to Grow." A post graduate course in self-culture will tend to upward growth. Such a course is open to every one. The greatest opportunities for that education which unfolds the whole nature of man are those which are opened when we close the college door behind us. Graduation only marks the beginning of education to one whose face looks forward and upward. Let us build high; "they build too low who build beneath the stars." Build so that life and strength and growth may vitalize the whole structure; build on lines that are straight; build so that every root and branch of the tree of knowledge lends support and does not add a twist to the whole; build that men may see in you not alone skill and wisdom, but honor, culture, manhood, example; study to improve self—

"For virtue only makes our bliss below,
And all our knowledge is ourselves to know."

OXYGEN ADDITIONS TO THE FURNACE BLAST

According to the report of Dr. F. W. Lührmann, of Berlin, to the Blast Furnace Committee of the Verein Deutscher Eisenhüttenleute on this subject, the managements of furnaces in Mülheim-Ruhr, in Ougrée and in Kratzwieck are using small oxygen additions introduced into the blast whenever the furnaces are working cold. They believe that a steady enrichment of this nature would be detrimental to the furnace lining. Dr. Lührmann, on the other hand, holds that with our advanced knowledge on cooling methods, this danger is not a very real one. The oxygen added is in the form of "Linde air," or 50 per cent. oxygen and 50 per cent. nitrogen. It is made by evaporating liquid air to a gas with 95 per cent. oxygen, and then further diluting with air to give the above mentioned composition. In the case of blast enrichment, naturally, the liquid air would be evaporated directly into the blast pipe and proportioned to give the higher oxygen percentage desired. An installation to furnish 17,500 cubic ft. of oxygen per hour would occupy a space 125 ft. square, and cost about $100,000, requiring 800 h. p. to operate it. Dr. Lührman finds that for every 1 per cent. oxygen addition to the blast volume, there is a possible rise in temperature of about 100 deg. F., not taking into consideration the specific heat of gases, etc., or 2,830 deg. F., as compared with the theoretical temperature of the CO obtained by burning carbon in air. This 1 per cent. oxygen addition to the blast volume, in a furnace of 240 tons daily capacity would add $2.50 per ton to the cost of the pig-iron produced, this being based upon a cost five times as high as that given by interested manufacturers. Should their price be correct the additional cost would drop down to $0.50 a ton of pig-iron made, and this cost is well worth while investigating with a view of emergency use when trouble sets in.

OZONAIR VENTILATING IN THE LONDON "TUBE"

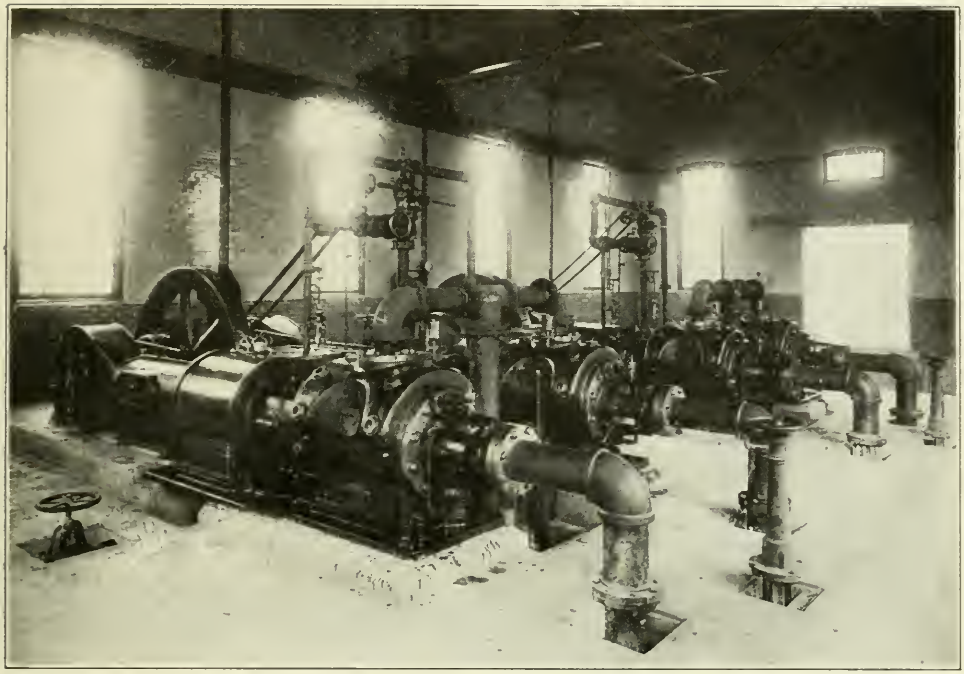
This system has recently been put into service by the Central London Railway. During the eleven years which have elapsed since its opening this railway has been ventilated on the exhaust system, the method consisting in closing all the doors underground for a certain period after the running of the last train, and drawing air right through the tube from one end to the other by means of a 200-horse power exhaust fan fixed at Shepherd's Bush. This thorough cleaning out every night was supplemented by a continuous running exhaust fan at the British Museum Station, and the natural ventilating action of the running trains. In view, however, of the increasing traffic, and the projected opening of extensions, the directors decided to instal a more positive system of ventilation. The railway runs a distance of nearly seven miles, and comprises two separate tunnels, having an aggregate length of about 13 miles. With the exception of a very short length between the first two stations, the railway is entirely underground. The "up" and "down" lines are in practically separate tunnels, each 11 ft. 8 in. in diameter, pierced in the London clay and formed of segments of cast iron bolted together. These tunnels are inter-connected at several points by "cross-overs," which greatly increase the difficulties of ventilation. The tunnels are at a depth below the street surface varying from 60 to 100 feet, with 13 underground stations.

The Ozonair system of ventilation consists briefly in drawing the air supply from as clean and pure a source as possible, and removing the smuts and other solid floating matter by means of special filtering screens. During this operation practically the whole of the sulphurous acid and other deleterious gases are absorbed. The cleaned air is then passed into a mixing chamber, where it is purified and partially sterilized by means of ozone. It is also enriched by the addition of a minute quantity of pure ozone. From the chamber it is distributed by means of ducts, etc. Included in the system is the provision at will of a heating or cooling coil, to be placed in the mixing chamber or other convenient position. The manner of distribution is worked out on its particular requirements, and the number of changes of air are calculated according to the the nature of the special circumstances of the case. Draughts are avoided, and the amount of air, and also the strength of the added ozone, can be adjusted at will; so that the atmosphere can be varied according to the temperature or state of the barometer.

In the Central London Railway installation, the equipment consists of a separate and independent plant at each station, with the exception of Shepherd's Bush, which is near the open end of the tunnel. The pattern of generator supplied in this case consists of a series of 10 generating units, each comprising a thin mica plate with a sheet of metallic guaze on either side, the set of ten plates being spaced and mounted on insulating supports. The gauze sheets are connected across the secondary of a small transformer delivering alternating current at a pressure of several thousand volts, and an innumerable number of minute discharges occur all over the opposing surfaces of the plates. Most of the equipments each pass normally some 360,000 cubic feet of air per hour, and the generator provides an amount of ozone sufficient to preserve the proper proportion. The proportion of ozone and the volume of air supplied can be regulated from the switchboards controlling each equipment. The main ventilating fans are of the "Sirocco" pattern and are driven in most cases by 7½-horse power motors. The ozone generator is supplied with current at 5,000 volts from a transformer fed at 380 volts A. C. from a small 550 volt rotary converter.

Many difficulties had to be overcome in the design of these rotary converters before they could be built to work satisfactorily, on account of their small size and high direct-current voltage, but the machines now in use are giving every satisfaction.

The equipments provided with 7½-horse power motors deliver from 5,500 to 6,500 cubic feet of air per minute, but the equipments at Holland Park and British Museum are designed to deliver the still larger quantity of 18,000 and 10,000 cubic feet per minute respectively, the former on account of there being no equipment at Shepherd's Bush. Altogether over 80,000,000 cubic feet of ozonized air are pumped into the tunnels every working day.



GAS COMPRESSORS, ST. LOUIS COUNTY GAS COMPANY.

HIGH PRESSURE GAS DISTRIBUTION AT ST. LOUIS, MO.

BY FRANK RICHARDS.

Here, in a recent installation of the St. Louis County Gas Co., St. Louis, Mo., is an example of the practical, established transmission of artificial gas at high pressure, and its direct delivery to consumers without the intervention of the district gas holder. There are gas holders of the familiar type at the gas-generating plant, where the pressure maintained is from 5 in. to 9 in. of water, the latter being the maximum pressure reached when the tank is full, and no other gas holders are required for the distribution system.

The compressors take the gas at this gasworks pressure and compress it to a maximum of 40 lb. gage. The pipes into which the compressed gas is delivered have a capacity of 20,000 cu. ft., and these constitute the entire storage for the gas after leaving the compressor. As a pressure of 10 lb. is sufficient for all purposes, the permissible range of pressures in this pipe system, about two atmospheres, allows fluctuations in the quantity of gas contained of about 40,000 cubic feet of low-pressure gas, although neither limit of pressure is actually reached in practice. The gas comes to the consumer at whatever may be the pressure in the pipes at the time, and then it passes through an individual pressure reducer, after which it is metered at the constant low pressure maintained.

This is not to be considered as in any respect an experiment, at least with this company, as they have been following this system of distribution for some years, and find that it not only gives satisfaction to all, but that it pays well. They have never experienced any trouble from deposits of any kind in the pipes and the gas is found to be practically as rich after compression and transmission as before. There also has been found no trouble or danger from the heating of the gas in the compressing operation, and there has been no accident of any kind.

In Fig. 1 we have a view of the interior of the compressor room. In one corner of this room, but not seen in this picture, is apparently a vertical receiver, the familiar accompaniment of the air compressor, but in this case it is instead a tar extractor through which the gas passes before entering the com-

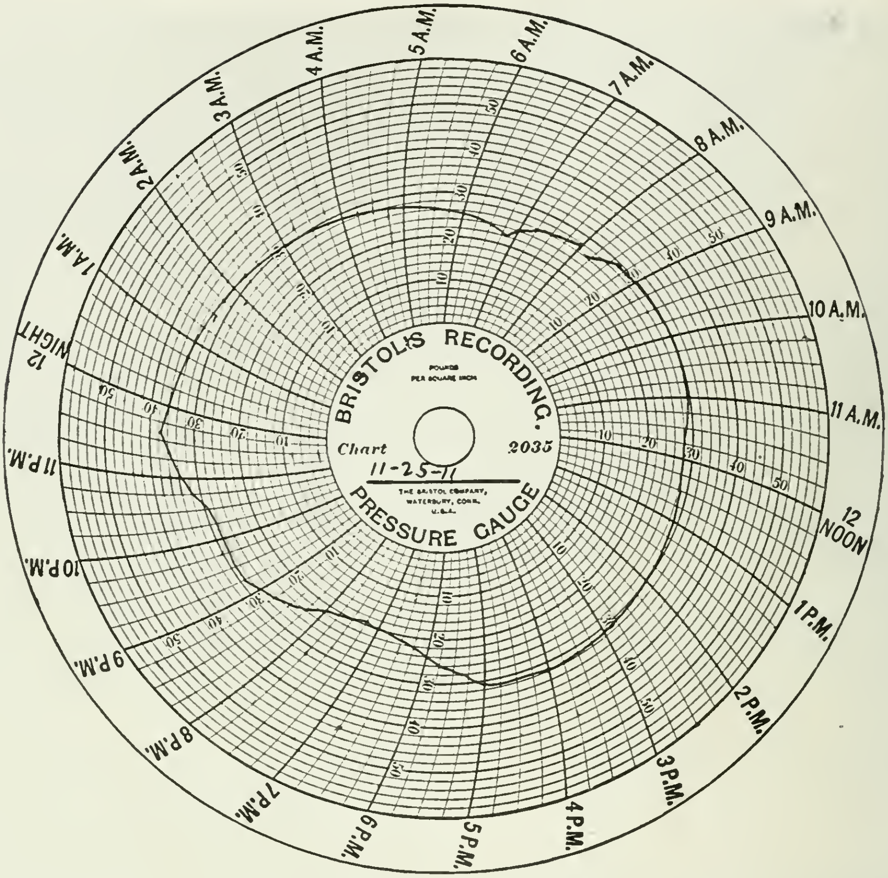


Chart Record of Gage Pressures in an 8-in. Gas Main at St. Louis, Mo.

pressors. These machines are two duplex gas compressors (Ingersoll-Rand, Class O) with cross-compound steam cylinders 12 in. and 23 in. diameter and duplex tandem gas cylinders 17¼ in. diameter with a common stroke of 18 in. and a normal speed of 120 r.p.m. The gas cylinders are, of course, completely water-jacketed. The mean horsepower is about 120 and the gas compressing capacity, with liberal allowances, about 1,500,000 cu. ft. per 24 hours. This approximates the present producing capacity, but considerably exceeds the consumption.

The compression of the gas under the conditions here presented is a very simple, or, as we might say, a very comfortable job for the compressors. The piston inlet furnishes an ideal means for connecting the intake, and the only automatic control required is a speed regulator, as on a stationary engine. This can easily be adjusted for different speeds according to the rate of gas consumption.

The gas is delivered into an 8-in. main, from which there are branches or continuations of 6-in., 4-in., 2-in., and 1½-in. pipes, the aggregate length of which may be inferred from the fact that the area served is about 120 sq. miles. The present number of customers is 6000, which number is being increased as fast as the pipes can be laid, the present daily output of gas being approximately 500,000 cu. ft. Only one of the two compressors is as yet required, and this is run 16 hours a day.

Fig. 2 is an accurate reproduction of a 24 hour record from the recording pressure gage, located near the beginning of the 8-in. pipe line. This record reads from 8 a. m., Nov. 25, to 8 a. m., Nov. 26, 1911. The record line coincides almost exactly with that of another gage 2¼ miles away, thus assuring us how lit-the loss of pressure there is in this transmission of over two miles, and suggesting that the same pipe may easily transmit twice or three times the present volume of gas.

The record line of the pressure-gage chart tells its story very clearly. The record begins a little after 8 a. m., and at 9 a. m. everything is running smoothly, the output of the compressor evidently keeping pace very closely with the eight mid-day hours to 5 p. m., a slight loss of pressure appearing about noon, when we may assume that some extra gas is used for cooking purposes. At 5 p. m. the demand for both lighting and cooking causes the pressure to fall quite rapidly for the next two hours. This is when the "peak" load occurs, the peak being represented on the diagram by a depression.

Before 7.30 p. m. the compressor output has caught up with the consumption. Then the pressure rises gradually until 9.15 and is nearly stationary until 10.15, when there is a rapid rise until 11.30. The upper working limit is nearly reached here and the compressor is stopped, as indicated by the sharp angle at 11.35. From this point until 6.50 a. m. the compressed gas in the pipes is sufficient to supply the demand. The drop is very rapid after 6 a. m., but after the compressor is started the line rises easily before 9 a. m. to the normal day working pressure of about 30 lb. The pressure where the record ends at 8 a. m. seems to be about 2 lb. higher than on the preceding day; perfect coincidence, of course, was not to be expected.

The system of high-pressure gas distribution is constantly extending, both in this country and in Europe, and entirely upon a business basis. It is found that the cost for installation, operation and maintenance of compressor and high-pressure piping is less than that of the much larger low-pressure pipes, the district gas holders and the land actually required, to say nothing of the depreciated land values which the community has to stand in the vicinity of gas holders.

The plant here spoken of is a comparatively small one. That the principle it embodies is practically applicable to much larger service is self-evident. That it is not applicable and that it will not eventually be applied to all gas service, however vast or concentrated, I am not asserting.—*Engineering News*.

CHEMISTRY AND THE ATMOSPHERE*

We live immersed in an ocean of air and we draw this air into our lungs approximately eighteen times a minute. The quality of this air, its temperature, pressure, humidity, the minute impurities which may be present, affect our comfort and well-being in many ways. It supports the chemical processes of combustion by which our existence is maintained no less than those upon which we are chiefly dependent for light and heat and power. The nature of this all-enveloping atmosphere of air has always been a subject of speculation, though to little purpose before the advent of chemistry.

Modern chemistry had its birth in the eighteenth century study of the air and its relation to the processes of respiration and combustion. Professor Ramsay has said that "To tell the story of the development of men's ideas regarding the nature of atmospheric air is in great part to write a history of chemistry and physics." The story is one which has reached its culminating interest in our own most recent times. For $35 you may now buy apparatus for reducing air to the liquid form and study the properties of matter at temperatures nearly as low as that of interstellar space.

Within the memory of the youngest undergraduate in chemistry the brilliant researches of Ramsay, Raleigh and other chemists have disclosed the presence in the air we breathe of five new gases of remarkable and in some respects unique properties. To one of these, neon, we now confidently attribute the long mysterious phenomena of the aurora borealis. Tubes containing highly rarefied neon may become as commonplace to our descendants as candles were to our forefathers. They glow with a rich, mellow, golden light on the passage through them of an electrical discharge.

The heavy toll of life in mine disasters would be unsupportably heavier were it not for the Davy lamp, the firedamp indicators, the rescue outfits and the regulation of explosives, all of which have become possible only through the growth of chemical knowledge. Ventilating systems as applied to theatres, halls and dwellings are based on chemical studies of the rates and causes of increase in the carbonic acid content in the air of rooms.

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*From *The Earning Power of Chemistry*, by Arthur D. Little. Boston.

The proportion of sulphur permissible by law in illuminating gas finds its justification in similar studies on the air in rooms in which such sulphur-bearing gas is burned.

One of the most insistent of the demands of growing plants is that for nitrogen in form available for plant food. A small proportion of the necessary supply of nitrogen in the assimilative form is derived from the manure of farm animals and from animal wastes of various kinds, but for many years the world has depended upon the nitrate beds of Chili as the chief source of this indispensable element of plant growth. It is bad enough to be tied in this way to a single far-away deposit, but the situation becomes alarming when we discover that this deposit can hardly meet the world's demand for nitrate for another twenty years. One may contemplate the Malthusian theory with indifference or even with disbelief, but here is a condition not to be gainsaid. The world must do something to meet it within twenty years or the world must make up its mind to starve. Fortunately for the world the chemists are already doing something. They have recognized that 33,800 tons of nitrogen are pressing down upon every acre of land and have boldly attacked the problem of rendering available such portion of this inexhaustible supply as the world may need. The methods employed have been daring and brilliant in the extreme.

In 1785 Cavendish in a paper before the Royal Society describes the production of nitric acid by the passage of an electric spark through air. A hundred years later Bradley and Lovejoy at Niagara Falls, by drawing air through an apparatus by which 400,000 arcs were made and broken each minute, demonstrated the possibility of the commercial manufacture of nitrates from atmospheric air. Birkeland and Eyde in Norway pass the air through furnaces in which it comes in contact with enormous flaming and rotating arcs. Rossi in Italy brings the air in contact with highly incandescent material of special composition. Although by these several processes nitrate has been produced by thousands of tons it is doubtful if the artificial product can yet compete with Chili niter. Even now, however, the margin is not a wide one and the results already accomplished amply prove that when our agriculture begins to feel the pinch of a failing nitrate supply the chemist may safely be relied on to meet the situation. This assurance is rendered doubly sure by the fact that a solution of the problem along altogether different lines is already nearly or quite within our hands. Dr. Frank has shown that by heating calcium carbide, itself a comparatively recent product of the laboratory, in a stream of nitrogen there is formed a new compound, calcium cyanamide. The practical interest in this compound depends upon the fact that when exposed to a current of steam it decomposes into ammonia and carbonate of lime and that the same reaction takes place slowly in the soil when the cyanamide is mixed therewith. Since the nitrogen in ammonia is directly assimilable by plants and since calcium carbide requires for its production only lime and coke and power we may view without serious concern the approaching failure of the Chilian nitrate beds.

COMPRESSED AIR FOR RAISING WATER

BY FRANK RICHARDS.

One of the most obvious uses of compressed air is that of raising and conveying water and other liquids, and this has also become one of its most extensive fields of employment. The variety of ways in which the air is applied for this purpose and the diversity of the apparatus that has been devised are astonishing. While many have nothing more than a historic interest; the actual, practical ways in which air now is employed for pumping, while differing widely from each other in efficiency and other particulars, are not numerous, yet they would be none the worse for still further elimination. The conditions under which the water is to be raised largely determine the specific device employed in the individual case, but sometimes other considerations not so defensible prevail in the selection or in the retention of deservedly obsolescent systems.

There is, according to the system adopted, much difference in the amount of air consumed as compared with the work done, but in all cases the former must be in excess of the theoretical requirement, as nothing can be done for nothing. With our present knowledge, it still pays in many cases to use air for raising water, in both small and large quantities, and as a means of permanent supply as well as in temporary or emergent cases.

It is desirable not only to do but also to know that we are doing the work as cheaply as possible. Our present facilities make the metering of water lifted or transferred an easy thing to do, and the raising of water, by compressed air or otherwise, can always be gaged with satisfactory accuracy, while records of such work are constantly accumulating and are accessible as guides to the engineer.

The theoretical horsepower required for raising water is

$$\frac{\textit{Pounds of water per min.} \times \textit{height of lift in ft}}{33{,}000}$$

The accompanying table may be taken as a starter; it furnishes the essential data as to the power required for raising water to different heights. It gives also the actual potential energy in the water so elevated, or the power which it should be theoretically possible for the water to develop in its descent to normal level if employed in a water-wheel or motor. When the power actually consumed in a water-raising operation is ascertained it can be compared with this table and the result will be an indication of the efficiency in the given example.

TABLE OF STATIC WATER POTENTIALS

1 Gal.	2 Volume, Cu.Ft.	3 Weight, Lb.	4 Potential Hp. in Water Raised 100 Ft.	1 Gal.	2 Volume, Cu.Ft.	3 Weight, Lb.	4 Potential Hp. in Water Raised 100 Ft.
1	0.13368	8.355	0.025303	200	26.736	1671	5.0606
2	0.26736	16.710	0.050606	250	33.420	2089	6.3257
3	0.40104	25.065	0.075909	300	40.104	2506	7.5909
4	0.53472	33.420	0.101212	350	46.788	2924	8.8560
5	0.66840	41.775	0.126515	400	53.472	3342	10.1212
6	0.80208	50.130	0.151818	450	60.156	3760	11.3863
7	0.93576	58.485	0.177121	500	66.840	4177	12.6515
7.48	1	62.5	0.18928	550	73.524	4595	13.9166
8	1.06944	66.840	0.202424	600	80.208	5013	15.1818
9	1.20312	75.195	0.227727	650	86.892	5431	16.4469
10	1.3368	83.55	0.25303	700	93.576	5848	17.7121
20	2.6736	167.10	0.50606	750	100.260	6266	18.9772
25	3.342	208.87	0.63257	800	106.944	6684	20.2424
50	6.684	417.75	1.26515	850	113.628	7102	21.5075
75	10.026	626.62	1.89771	900	120.312	7519	22.7727
100	13.368	835.50	2.5303	950	126.996	7937	24.0378
150	20.052	1253	3.7954	1000	133.680	8355	25.303

The first column gives the number of gallons of water lifted; column 2 gives the volume in cubic feet of the given number of gallons, while column 3 gives the weight in pounds of the same quantity of water. Column 4, assuming that the given quantity of water—gallons, cubic feet or pounds—is raised to a height of 100 ft. in a minute, gives the horsepower theoretically required for the lift, or the horsepower which should be developed by the descent of the water to its original level. Any other figures or quantities not in the table will be in direct proportion to those given.

DRIVING STEAM PUMPS WITH AIR.

First of all (as an example of "how not to do it") consider what it costs to drive an ordinary, direct-acting steam pump by compressed air. It is often so convenient to do this, in mines, tunnels, excavations for foundations and elsewhere, that it is done generally without counting the cost, either before or after.

The simplest case is where the steam or air and the water cylinders are of the same diameter, and have the same stroke. Here if there were no allowances to be made for clearance losses, leakages, power required to overcome friction and inertia, and if it had cost nothing to compress and transmit the air—all these and other things being those which pure theory is so apt to belittle or ignore—the volume of air at the balancing pressure would just equal the volume of water delivered and the efficiency would be 100 per cent.

The standards of efficiency which we call the possible efficiencies are really the impossible efficiencies. It is well known that they can never be attained, and very far from it in the present case. The air pressure must be enough in excess of the water pressure to overcome the frictional resistance of the machine itself and of the water in contact with the surfaces in its restricted flow through valves and passages, and to give and maintain sufficient impulse in the otherwise inert column. For all this it will be proper to allow an initial deficiency in the air power at the pump which will average not less than 20 per cent., and the

100 per cent. efficiency with which the author started is reduced to 80 per cent.

But if there is such a deficiency, the pump will not go. This is understood; and the several deficiencies are anticipated and provided for beforehand by furnishing air in sufficient volume and at an excess of pressure to overcome them.

To run a pump comfortably the working pressure of the motor fluid should be somewhat above the actual requirement, but it is not necessary to speak of that here as affecting the power consumption.

Next, the matter of cylinder clearance may be considered, which is interesting in the direct-acting steam pump at any time, and especially so when the pump is driven by air. Nothing need be said about clearance losses in the water cylinder, for practically there are none, as all the spaces may usually be assumed to be filled solidly with water, and if everything is in good order all of the actual travel of the water piston is represented by water delivered.

Enough clearance losses in the air cylinder may be found to satisfy for both. The direct-acting pump has no crank to bring the piston to a dead stop always at the same point at the end of the stroke, and, as at the same time it must be certain that the piston shall never strike the head, very large clearance is provided. The filling of this large clearance, together with that of the unavoidable clearance spaces in the passages between the valves and the cylinder, entails another large excess of air over that theoretically required, or a deficiency of work done as compared with the air consumed of, say, another 20 per cent. This percentage of 80 being 16, 64 per cent. of the original 100 at this point is left.

There is a third great loss of efficiency when compressed air is used to drive a direct-acting steam pump because the air is used at full pressure and shows none of the advantages of being used expansively. If, instead of using the air at its highest pressure to fill the cylinder to the very end of the pumping stroke, it could have been used in a crank-and-flywheel pump, or in one of any other design in which the air could have been cut off at the proper point of the stroke, so that it would have been discharged at a pressure nearly that of the atmosphere, then the work done for the quantity of air used would have been, on the average, varying with the initial pressure of the air, say, 50 per cent. more than without the cutoff and expansion. That is, it could and would have done one-half more work, and the failure to do this amounts to another deficiency of one-third, or, say, 33 per cent. This percentage of 64 being 21, there is left only 43 per cent. of the original 100, and this diminution of efficiency is all realized after the air has arrived at the pump and without looking to the losses which have accumulated previous to its arrival on the job.

NOT TO BE CHARGED TO THE AIR.

Now, the curious thing is that not one of the losses here mentioned, nor any portion of any of them, is in any way chargeable to compressed air. They all inhere in the apparatus and in the system by which the air is applied to the work of lifting the water.

One loss peculiar to steam and entirely absent with air is the loss by condensation, concerning which it is not necessary to present any figures. It is plain that the air should not be blamed for any of the losses of which it becomes the agent when driving the steam pump.

Thus far, the direct-acting pump alone and its deficiencies or those which it entails, have been considered. Of course, the pump has nothing to do with the friction losses in transmission from the compressor to the pump. For all such losses and for all possible leakages allow, say, 5 per cent., deducting which from the 43 per cent., found above, leaves 41 per cent., all the rest having disappeared after the air left the compressor. The transmission loss just allowed would be greater with steam, while some of the distances which air may be carried are prohibitive with steam.

While the cost of compressing the air used is not considered, attention might be called to the approximate figures for compressing free air to, say, 80 lb., gage. Assuming a steam-driven, reciprocating air compressor and both compressor and pump to run regularly under their respective rated loads, the power which is being developed in the steam cylinder may be taken as a starting point or the basis of efficiencies First must be deducted a sufficient allowance for the friction of the entire machine and for the leakage and clearance and other air-cylinder losses, amounting altogether to an inefficiency of at least 20 per cent., leaving 80 per cent. Then in the compression of the air the excess of power required for the actual adiabatic compression, instead of the theoretical isothermal compression, will be 34 per cent. This percentage of 80 being 27, the surviving efficiency will be 53 per cent. This being the efficiency of the compressor and 41 per cent. the pump efficiency, the ultimate efficiency of the combination is 21.73 per cent.; that it, it will take about 5 hp. in the steam cylinder of the compressor to realize 1 hp. in the actual lifting and delivery of the water. Actual results are seldom any better, and often much worse, than this in practice.

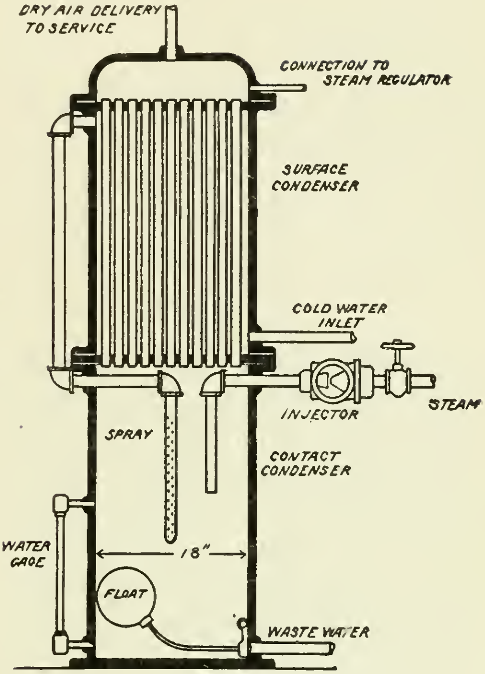
At least one hint may be taken from these figures, which is that the loss is the least where the working air pressure is the lowest. In the case of the direct-acting pump the difference may be made in the relative capacities of the air (driving) and the water (driven) cylinders, and, in general, the larger the former is, the better. Thus, supposing the air to be used at 40 lb., gage, instead of 80, the excess of mean effective resistance in the air compressing cylinder in the act of compression would be only 22 per cent. instead of 34, and the loss in the air cylinder of the pump through not using the air expansively, would be relatively the same, so that there would be a saving at both ends.

DIRECT STEAM FOR AIR COMPRESSION

The sketch here reproduced from the Louisiana Planter shows a novel type of air compressor which is finding special employment in the sugar industry. It furnishes comparatively dry air for such purposes as ventilation, for mixing liquids in tanks (as in blending water with molasses), keeping liming tanks stirred and giving the low pressure blast needed for vaporizing sulphur burners.

An installation of this kind is now giving satisfaction in stirring water into high-density liquor to bring the product to standard density, blending a volume of about 10,000 gallons perfectly in about twenty minutes.

Essentially the principle is the use of steam in a special injector nozzle to drive air into a storage chamber, this chamber being provided with a water-spray which condenses and removes the steam that passes along with the air. A small jet of steam ⅛-inch to 3-16-inch nozzle—and a very small water consumption give a remarkably large volume of air at pressures ranging up to 15 pounds gage, and dry enough to use for the combustion of sulfur without forming excess of sulfuric acid.



DIRECT STEAM AIR COMPRESSION.

There are no moving parts whatever excepting the float, and the apparatus is thus as simple and dependable as a steam trap, and requires as little care or operating expense. The cost as compared with mechanical air-compressors gives this device all the advantage, since it is always ready to run as soon as steam is turned into it; needs no oil or packing, nor tightening of stuffing-boxes, has no wearing parts, and can be set for any desired amount or pressure within its range by the steam admission valve, and a steam regulator valve can be used to control the pressure.

Reference to the illustration shows the injector with its steam connection forcing steam and air into the contact (or direct) condenser cylinder, where the steam meets the spray of water and all disappears, the air continuing upwards into the tubed surface condenser where the cold surface removes practically all of the remaining moisture and cool, dry air is delivered through the pipe at the top in to the service line.

Cold water, which must have sufficient head to overcome whatever air pressure the apparatus may be working at, is admitted first into the surface condenser shell and, after passing around the tubes, passes through an external pipe into the sprayer of the direct condenser, finally running off through the waste pipe to the boiler or elsewhere.

The surface condenser is used only when the air must be as dry as possible. For tank stirring and ventilating only the contact condenser is used and the cover cap fitted directly upon it. By heating the current of dry air, it can be used to great advantage for drying sugar as it passes the chute into the bins.

The apparatus is of cast-iron, excepting the copper float and the iron tubes. At 75 pounds steam pressure about 0.26 h. p. per hour is used for operating this compressor.

FLIES ARE NOT FRIENDS OF MAN

The Welfare Committee of the Iron and Steel Institute issues the following note of warning about flies:

Flies are a dangerous nuisance, they carry disease. People are just beginning to wake up to this fact. All flies are dangerous; house flies are especially so, because they are so numerous and because they come in contact with people and foods. A single family fly lays an average of 120 eggs at a time. Four deposits of eggs may be made by one fly. Under favorable conditions the eggs become flies in about ten days. It takes about ten days more before these flies also lay eggs. It can be readily seen how fast flies will multiply if they are not destroyed. They have no choice between the cleanest kitchen and unmentionable filth. Flies may infect foods with disease germs. They spread typhoid fever, as typhoid fever is a germ disease. Flies deposit typhoid germs in butter, milk and other foods—therefore, butter and milk should be kept covered and so should all other foods where possible. The germs deposited by flies are especially dangerous to infants and children. Flies like to feed around the eyes of sleeping children, and in so doing, may cause serious eye disease. Flies must be kept from entering dwellings; all windows should be screened. Foods should be kept screened and tables should not be kept continuously set.

DOUBLE VACUUM DIE CASTING

BY ETHAN VIALL.

One of the great difficulties encountered by makers of die castings has been the liability of the castings to be porous or full of air holes at the place where least desired. These blowholes have been caused by air being confined in the mold when the melted metal entered it.

The general practice has been to exhaust the air as much as possible from the mold just previous to letting in the metal, but the vacuum created in the mold has caused some of the metal to spray into the mold from the melting pot, which metal seals up to a greater or less extent the vents of the mold. Then when the metal for the casting was forced in, there was air in the mold which had no place to get out, or if there was an opening for it, it was too small to let the air out fast enough and blow-holes were the inevitable result.

In fact, considering the speed at which the metal for the casting is forced in, an opening almost as large as the gate itself would be needed to let the air out fast enough to prevent bubbling, in which case no vacuum of any description could be maintained.

In order to overcome the difficulties just mentioned, C. M. Grey, of the C. M. Grey Manufacturing Co., East Orange, N. J., some time ago invented a machine in which a double vacuum is used; a vacuum in the die and a vacuum back of the melted metal.

The two vacuums are evenly balanced up to the instant of filling the die, when the metal is forced in by compressed air, this plan preventing the "leakage" of air into the die, and consequently there is nothing in it to cause blowholes when metal is cast in.

THE CASTING MACHINES.

In order that the reader may have a clear idea of how this is done, we will proceed to illustrate and describe the casting machines in detail.

A view of an individual machine is shown in Fig. 1, in which *A* is a die set into a carrier which may be swung back when the die is to be opened for the removal of the casting; *B* is the lever which operates the lock used to hold the die carrier firmly down onto the top of the metal tank; *C* is the handwheel by which the operator governs the vacuum and air vales; *D* is a vent pipe for the products of combustion; *E* is the pipe to the gas heater used to melt the metal, and *F* are exhaust tubes connected to the die through which the air is pumped out.

Referring to the opposite side of the same machine, Fig. 2, the letters correspond, but with the addition *G*, which is the lever used to open the die; *H* operates the gate; *I* works the mandrel in a threaded part of the casting made in this die, and also forces out the ejector pins; *J* is the valve box; *K* is the vacuum gage and *L* is a vacuum equalizer containing a metal diaphragm, which is connected to valves leading to the vacuum pipes for both the die and the metal pot.

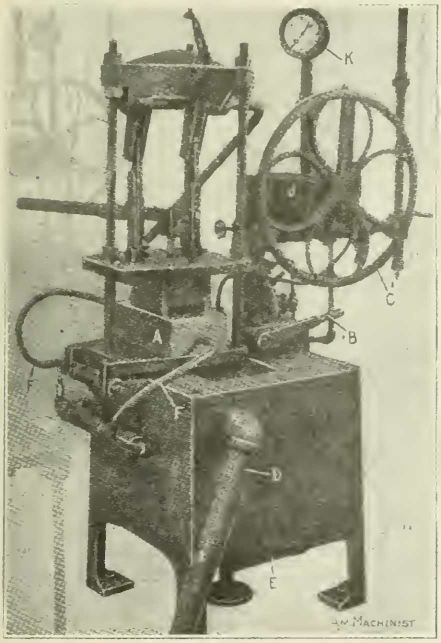


FIG. 1.

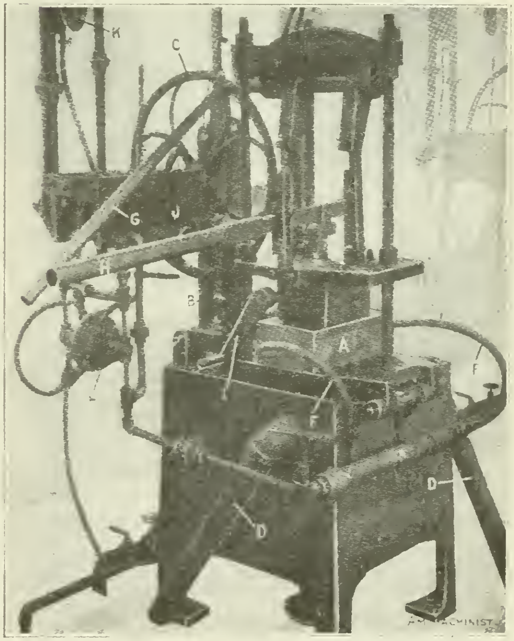


FIG. 2.

As the vacuum gains on one side, the diaphragm is pulled over; this opens the valve on the opposite side a little wider and allows the vacuum to increase, and *vice versa,* the action of the diaphragm automatically keeping up until the desired vacuum is attained equally on each side. The arrangement of the die and metal pot will be gone into in detail further along in this article.

One of the machines open, with the parts of the die separated, is shown in Fig. 3. The die carrier is counter-balanced by a cord and weight to make it easier to handle, and when thrown back rests on a wooden support, as shown.

The die shown here is different from the one illustrated in Figs. 1 and 2; the lower part is shown at *A,* the upper part being drawn back at *B* by swinging around the lever *C.* A part of the vacuum chamber for the metal pot is shown at *D; E* is the opposite end or spout of the pot, through which the melted metal enters the die when the carrier is in position; *F* is the supply tank from which the metal pot is replenished as the castings are made, the metal simply being dipped with a ladle from the supply tank and poured into the spout.

DETAILS OF THE DOUBLE VACUUM.

The line engraving, Fig. 4, shows the method of obtaining a vacuum back of the metal to be cast, at the same time a vacuum is obtained in the die. This engraving was taken from the patent specification, and while not exactly the same as the plan of the machines photographed, it serves to make plain the principles of the apparatus.

In this, *A* and *B* represent the two parts of the die body, and *C* the die cavity, shaped to form the casting desired; *D* and. *E* are vents

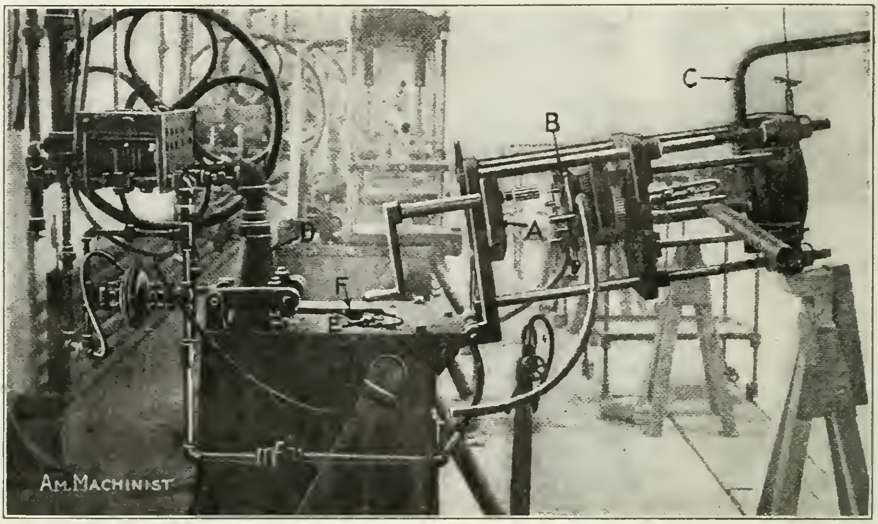


FIG. 3.

through which the air is exhausted from the die through the pipe *F*; *G* is the gate of the die which rests directly over the spout *H* of the metal pot *I*.

In actual practice there is a valve or plunger used to close the gate and shut off the melted metal after the die is full. The operation of this is familiar to die-casting operators, though not shown here.

At the end of the metal pot, opposite the spout, is a vacuum chamber *J*, to which the pipe *L* is connected. This pipe not only connects with the vacuum pump at *M*, but also to the compressed-air pipe at *N*. The exhaust pipe *O* has two branches, *P* and *R*, which lead to the vacuum chamber of the pot and the die, respectively, through the valves shown in each branch.

The pipes *S* and *T* lead from the two exhaust pipes above the valves to chambers on opposite sides of the diaphragm *U*, so that excess of vacuum in either the metal pot or the die will cause the diaphragm to move toward the side on which the vacuum is greatest, partly closing the valve on that side and correspondingly opening the valve on the opposite side. In this way an equal vacuum is obtained on both sides of the melted metal and pre-

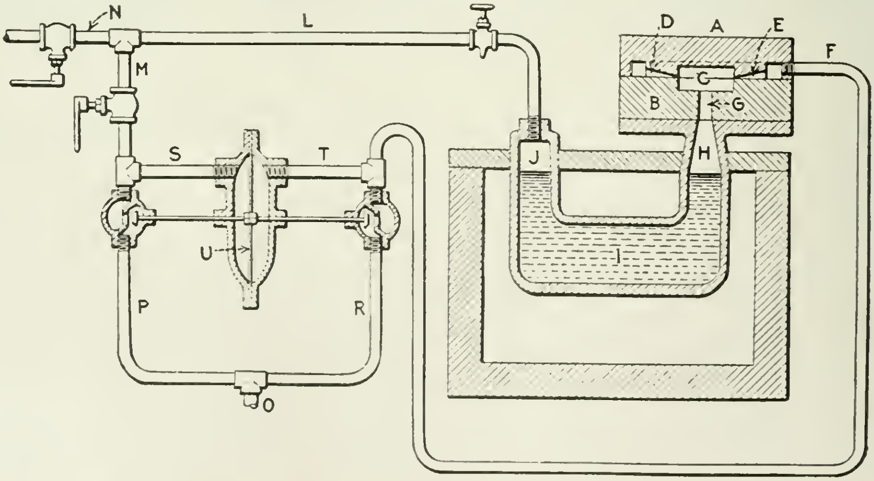


FIG. 4.

vents the entry of air, gas or melted metal into the die, without the interposition of mechanical means.

When the balanced vacuum has reached the desired amount, as indicated by the gage, the suction is shut off at *M* and compressed air is instantly let in at *N*, which goes through the pipe *L* and forces the melted metal up into the die.

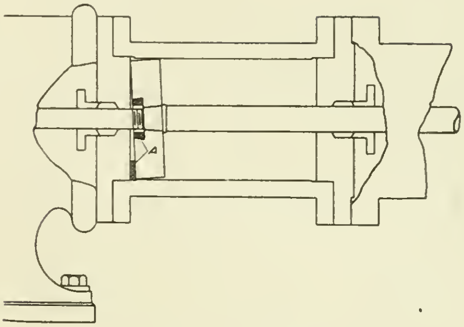
The method of employing a vacuum on both sides of the melted metal previous to casting, effectually prevents porousness or blow-holes in the castings.—Condensed from *American Machinist.*

REFINEMENT IN COMPRESSOR CONSTRUCTION—AND THE TROUBLE IT CAUSED

The compressor was of the 2-stage type, with duplex steam cylinders and was known as a 10 and 10 by 16 and 10 by 10 compressor. The 10 by 10 steam cylinders were attached to the main frames with the air cylinders arranged tandem behind them, with a short distance piece between. Steam and air piston heads were held on the piston rod by means of a taper fit, with a recess, slightly reverse-tapered, as shown in the cut, in each head, into which fitted the nut which held the piston head in place.

The piston rod was 2 in. in diameter at the air end, but only 1¾ in. at the steam end. In order to get the steam piston head on the rod, it was slipped over the rod from the crosshead end and fastened with the nut and *the space around the nut filled in with babbit, so as to reduce the clearance* as much as possible. And this was where the weak point occurred. The recess in the steam piston did not have taper enough to hold the babbit and examination showed that possibly the core fell away in casting the head, so that the metal had to be bored out, leaving the inside of the recess so smooth that it would not hold the babbit.

After the machine had been in operation about 2 months, suddenly one day the compressor, while running about 35 r.p.m., stopped and investigation showed that the crank on the second stage side was on the center and that it required 3 men with a lever 16 ft long to move the wheel. When started, the machine showed considerable distress, but as air was needed badly the engineer was instructed to keep the compressor in operation for the rest of the day, if possible.



THE BABBITT DROPPED OUT.

Two hours later, the machine gradually slowed up and stopped and no amount of skill could move it. The distance piece was taken off the side that showed lame and the back steam cylinder head removed; the top and bottom of the inside showed that there was an enormous pressure there. A small try square was inserted and the piston head was seen to be out of square fully $^{3}/_{16}$ in. on the diameter.

It was then a matter of learning the cause of this effect. Believing that the cause was on the other side of the piston, but not knowing just what it was, the engineer disconnected the piping and removing the bolts, slipped the steam cylinder back off the front head and there he found the trouble. The babbitt had cracked radially from the corners of the jamb nut and a sixth of it had worked out and dropped into the clearance space at A and when that crank had crossed the center, this piece of babbit, which was about ⅞ in. square by about 1¼ in. long, was squeezed up to about $^{3}/_{16}$ in. thick and 2 by 3 in. in general dimensions.

One piece having dropped out, the other five were quite loose and although they were hard to remove in the limited space it was not thought best to leave them in, so by means of two blow torches the remainder of the babbit was melted out, when the jamb nut was set up tight and locked with a round nose chisel. While in this position, it was learned for a certainty that the piston rod was sprung so much as to throw the piston head out of square as shown, and the edges of the piston head rubbing on the walls of the cylinder were what caused the excessive friction.

The compressor was assembled and again put in operation and, by using plenty of cylinder oil and graphite, friction was gradually reduced considerable, and air supplied to the factory. In just a week the same thing occurred to the other side, and, knowing the cause, the repairs were soon made and the machine running, but with an enormous friction load.

The manufacturer of the machine was appealed to and finally supplied a set of new piston rods. Replacing of the sprung piston rods was not attended with any great amount of pleasure, but when once placed in operation (without the babbit filling) the engineer said that he had a peace of mind that he never knew before.—Condensed from *Practical Engineer.*

CONGRATULATORY REMINISCENCE OF COLLEGE AND MANUFACTORY

[Abstract of the address of F. A. Halsey, M. E., at the dedication of Rand Memorial Hall, Sibley College, Cornell University, Ithaca, N. Y.]

To a Sibley alumnus of the early days, this occasion is primarily one of reminiscence. My thoughts go back to the time when technical education was a new and untried thing, and not only new and untried, but looked upon with skepticism and even aversion, when the Sibley shop and its students in overalls were objects of amused interest to academic visitors, whose educational horizon took in nothing beyond a classical education, men, who could see no value in systematic training for careers similar to their own.

Those of us who formed the early classes in Sibley know better than those of to-day can ever know, the scant sympathy with which this educational movement was received. The graduate of to-day may not always find the door of employment wide open for him, but he is at least spared the supercilious air of superiority with which the proffer of the services of the early graduate was too often rejected.

No retrospect of this kind can fail to compare the feeble beginnings of this movement with its present noble stature, and the building that we are here to dedicate supplies a gauge of progress which all can see. This is to be a shop building and we have but to compare it with the Sibley shop of the 70's. That early shop was housed in the west room of the first floor of what we must now call the original Sibley building, and I am bound to say that, even in those seemingly narrow quarters, there was no crowding, either of equipment or of students. Small as the quarters were, I distinctly remember that there was room for more than came.

By excellent authority we are told to despise not the day of small things, and the student who imagines that more earnest work is being done on this campus to-day than was done here thirty-five years ago, needs to have that impression corrected. Perhaps I can give my own appreciation and estimate of that work no better than by repeating what I said to the students at Columbia last winter, that they were going to get a lot of second hand teaching handed down from Professor Sweet; and I am bound to say that of what they got from me, the best was that same second hand assortment.

This building is to stand as a memorial to the brothers, Jasper R. and Addison C. Rand, and Jasper R. Rand, Jr., and because of my association in business with these brothers, I have been asked to say something about their personalities and their work.

Someone has said that the only way to know a man is to work for him. If this be true, I ought to have known these brothers, for I was in their service for a period of twenty years—fifteen years actively, and five years more in a consulting capacity.

First let me say that they were *brothers,* by which I mean, not only sons of the same parents, but brothers in every best sense of that word. Associated in business throughout their business lives, the mutuality of their interests, their mutual forbearance, and their manifest mutual regard, was perhaps the most striking feature of their association.

Of them I knew the younger brother, Addison C., far better than the elder, Jasper R. The mechanical side of their business, which ultimately dominated, was the outgrowth of a previous business in high explosives. It was this older branch which was in charge of the elder brother, while the mechanical side with which I was exclusively connected, was in the hands of the younger brother. Moreover, for many of his late years, the elder brother was not in robust health, and this, with the growing predominance of the mechanical work, led to his gradual withdrawal from active management.

No one, however, who ever came in contact with Jasper R. Rand, can forget his genial spirit, his ready wit, and his quickness for repartee.

Of the son I knew even less than of his father. During my active days at the office he was but a lad, and as he grew to manhood after I had gone elsewhere, I naturally saw but little of him. He was better known on this hill than I knew him; for he was a Sibley graduate. It is doubtless known here that on the outbreak of the war with Spain, he enlisted with the First New York Volunteer Engineers with whom he saw service in Porto Rico, where he contracted typhoid fever, from which, however, he happily recovered.

The death of his father and uncle placed heavy responsibilities on his young shoulders, which he was just beginning to learn to carry when his untimely death cut short a business career of greater promise and opportunity than any that I have ever personally known.

The work which these brothers did was, of course, the development of the rock drill and the air compressor, the latter at the beginning being essentially an adjunct of the former. The rock drill had its real beginning at the Hoosac Tunnel, which was driven by the Burleigh drill. Another, a still older brother, Albert T. Rand, had been the moving spirit in establishing the Laflin and Rand Powder Co., and to this company came plans for a rock drill intended as a competitor of the Burleigh, which was then the only commercial machine. Addison C. Rand's already demonstrated mechanical ability led his brother to turn the investigation of this machine over to him, and the result was a condemnation of it.

Knowing as we now do the requirements of these machines, it is easy to see that Mr. Rand's foresight was as sound as is our hindsight. The circumstances under which the later machine with which they became identified was brought to his attention I never knew, but the subsequent history of that machine and the magnificent business of which it was the foundation, show that Mr. Rand's judgment was as sound in accepting the one as in rejecting the other, and these two incidents point out his most striking characteristic, an unfailing judgment, and not only of things but of men.

It is, of course, the nature of education to glorify intellect, and perhaps, before this audience, I shall say an unpopular thing when I affirm that, as I see the affairs of men, it is not intellect that moves the world, but judgment: that quality, akin to instinct, which guides us when all rules fail, that knows what to do and what not to do, when to act, and when not to act; and it was this quality, which with one other, pre-eminently characterized Mr. Rand, that other being patience; limitless patience, willingness to wait, with faith in the outcome; and in the business which was being founded he had every need of both.

Perhaps no machine that ever came from the brain and hand of man is less indebted to the engineering practice of its time than the rock drill. It was only partly a matter of invention, though the inventive problems were serious enough. Behind all such problems, was the all pervading problem of material, and in the solution of this problem, less than no help was to be had. It was not that there were no guides. There were guides in plenty, but they all pointed in the wrong direction, and the more effort was made to do what prevailing practice said was right, the worse were the results.

The rock drill is, of course, primarily, a machine for resisting shock, with the added feature of portability. Minimum weight being essential, when parts break the rock drill designer is denied the common recourse of making them larger, his only recourse being to find a more suitable material. Moreover, in the early days, the solution was never complete, for in constant pursuit was the demon of high pressure. When the machines had been made to stand up fairly well, under 60 lbs. air pressure, the users promptly raised the pressure to 70 lbs., and then to 80 and to 90, and what figures have now been reached I do not know.

This problem of material was thus fundamental and, in solving it, all tradition had to be broken and "sound practice," as then understood, had to be discarded, because such practice was absolutely wrong, and in solving it the brothers Rand taught the engineering world a lesson that made it their lasting debtor.

The first lesson was learned on the piece called the rocker pin—a steel pin the size of one's little finger, and subject to repeated and violent shock. Formerly the operator would begin his day's work with a pocket full of these pins to replace those broken, expecting to bring back but few of them at the close of the day. The correct material was found as the result of an aimless trial of every material that offered, the final selection being a special imported *high* carbon steel. No one had then the courage to suggest that the results were due to the high carbon percentage. They were believed to lie in some mysterious property of this special steel, and the lesson went no further.

I might detail other experiences of the same kind, but that would accomplish nothing. I cannot, however, give you an adequate idea of the situation while this condition lasted. Perhaps the most trying of all these experiences, was on the then new New York aqueduct, the second Croton aqueduct, where the piston rods began to break in wholesale manner as the rockers had done before. The aqueduct was divided into two sections, which were under different contractors, one section being equipped with Rand and the other with Ingersoll machinery. I doubt if there ever was a more keen and relentless rivalry than existed between these two companies at that time, and we had every reason to know that their piston rods did not break.

As a matter of fact, they were as full of trouble with compressors as we were with drills, but that we did not know, until too late to get even comfort, let alone compensating advantage.

All this is but to point out those qualities of judgment and of patience of which I have spoken, the former manifested here in breaking with a practice that had the sanction of every authority, for I well remember the keenness of Mr. Rand's analysis, in the face of everything published, when the accumulation of facts and experiences had gone far enough to point out the principle that lay beneath them, and the conclusion that in its precepts the engineering world was wrong.

This phase of his character I hope I have made reasonably clear, but the bearing of these experiences upon that other phase, his limitless patience, is beyond us. Only those who have been through similar experiences in founding a pioneer business can appreciate it. To bring back the business rivalry of the times, the manner in which this rivalry was utilized by impatient customers and by others, to whom stronger words might apply, to explain the load of anxiety to which all this led, and the unfaltering faith with which it was all carried, this I cannot do in any manner that seems worth attempting.

But it all had its reward in its ultimate success and in another outcome, which to both these brothers was, I believe, of greater value than business success. I mean the spirit of absolute loyalty and devotion on the part of their entire body of employees which I have never seen equalled and which, at the end, was rewarded in a manner that showed how profoundly it was appreciated.

And in view of it all, what an appropriate memorial this is! A building of lasting usefulness in the high cause of education; more specifically, a building for a school of engineering provided from funds accumulated in an engineering business; and more specifically still, a building for a university machine shop, provided from funds accumulated through the work of a machine shop. It seems to me that the donor has been singularly fortunate in her selection of a memorial and that those in whose name it stands could have made no better choice. Could they have foreseen this, as one of the outcomes of a life time of trial, it could only have been another recompense for those trials.

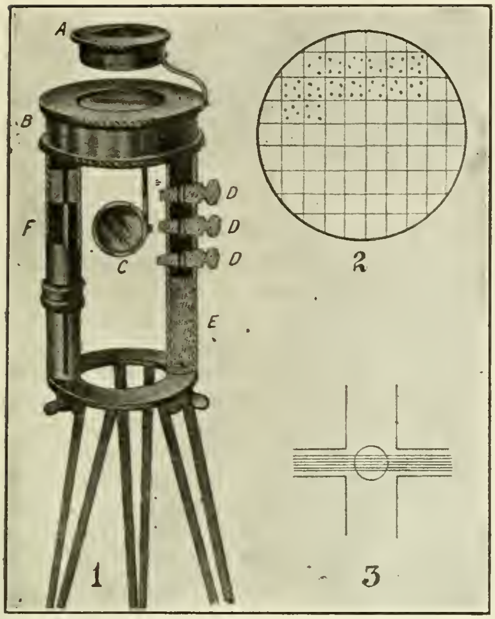
COUNTING THE DUST IN THE AIR

There are various methods of measuring the dust in the air. A known volume of air may be drawn through a filter of cotton wool, or bubbled through distilled water, and the dust detained by the cotton or deposited in the water may be weighed. Most forms of apparatus used in studying dust serve only to show the total weight per unit volume of air, or provide means of securing specimens for microscopic examination.

The majority of dust-particles, however, are ultra-microscopic, and it is a matter of much interest—especially in connection with the study of the condensation of atmospheric moisture—to determine the total number of particles, regardless of their weight, present in a unit volume of air at any time or place.

This is effected by means of Aitken's dust-counter, one of the several forms of which is shown in the accompanying illustration.

The instrument is shown, partly in section, at 1. *B* is a shallow circular metal box of known capacity, having glass plates at top and bottom. It stands upon two cylinders opening into it. The cylinder shown at *F* contains a piston, and serves as an air-pump. In the other cylinder there are three taps, *D D D*, the bores of which hold measured volumes of air.



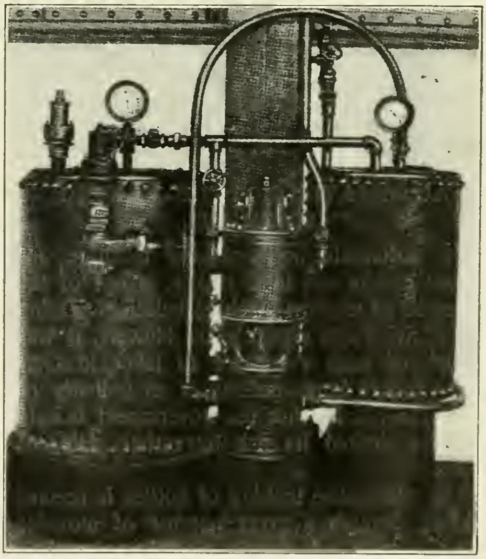
At the bottom of this cylinder there is a plug of cotton wool, beneath which there is a small hole through which the air may enter. At *A* is a magnifying glass, and at *C* a reflector, for illuminating the glass plate at the base of the box *B*. This plate is divided into measured squares, etched on the glass (shown at 2). The atmosphere within the box is kept saturated with moisture by means of strips of damp blotting paper.

The instrument is used in the following manner: The piston at *F* is drawn down, while the taps are in the position shown in the diagram. Air is drawn through the plug of cotton wool and thus enters the metal box free from dust. The instrument is now ready for testing a sample of air. One of the plugs is turned so as to communicate with the outside air, as shown at 3. It is then turned back, so that its bore again communicates with the metal box, into which a known volume of dusty air is thus admitted. One or two rapid strokes of the piston now serve to cool, by expansion, the air in the metal box; drops of moisture form and are deposited on the glass plate, where they may be counted. (See 2.)

Each of these drops is condensed about a particle of dust; hence the number of drops represents the number of dust particles. The latter may themselves be far too minute to be visible under the highest power of the microscope, but they reveal their presence by becoming the nuclei of condensation.

If the outside air were admitted freely to the metal box and the latter were then closed, the drops formed by sudden condensation would be far too numerous to count. However, by diluting a small volume of dusty air with a large volume of pure air, in the manner above described, the drops are easily counted; and it only remains to multiply the result by a factor corresponding to the degree of dilution to determine the dustiness of the outside air, expressed in the number of particles.

Aitken and others have made innumerable tests of the air in all parts of the world. The number of dust particles has been found to vary from a few thousand per cubic inch over the oceans and in mountain regions to 50,000,000 and upward in dusty towns. A room, near the ceiling, has been found to contain 88,000,000 to the cubic inch. Aitken tells us that a cigarette smoker sends some 4,000,000 000 particles into the air at every puff.—*Scientific American.*



A PNEUMATIC POP-SAFETY VALVE TESTER

The half-tone which we here reproduce from the American Machinist shows an outfit in use in the 'Frisco railroad shops, Springfield, Mo., for testing pop safety valves for locomotives. The air reservoir at the right is connected to the shop air line, and its gage indicates the shop line pressure which is maintained at 90 lb. A connection with stop valve leads from this to the reservoir at the left and when this is filled to the shop pressure the valve is closed. Air is then admitted to the pump—an air brake pump always to be picked up in a railroad shop—and the pressure is pumped up to 240 lb. at which its safety valve is set.

The air gage on this reservoir is connected to a piece of 2-in. pipe 24 in. long, the lower end having a $^1/_{32}$ in. opening, leaving the pressure steady so that the needle of the gage is free from vibration while the pump is working. The operator can thus see exactly how many pounds the valve being tested will lose before popping.

The pop to be tested is fastened to a large gate valve on the front of the left-hand reservoir, various sizes of nipples being used for different makes and sizes.

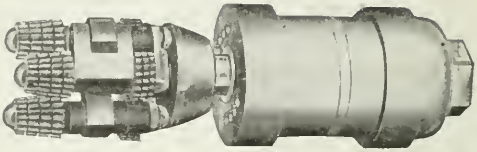


FIG. 1.

AN AIR DRIVEN TUBE CLEANER

The little half-tones on this page show a boiler cleaner made by the Lagonda Manufacturing Company, Springfield, Ohio. Fig. 1, is an external view of the device complete. It is essentially an air driven rotary motor which is geared to the group of toothed cutters which do the work. These cutters may be of any of the different types in use.

Figs. 2 and 3 will give a good idea of the construction and operation of the motor. The compressed air or steam passes through two ports in a plate in the rear end of the cleaner then through transverse openings in the rotor, and out through branch openings to the space behind the paddles. There are only two ports opening into the air chamber, so that only the two paddles which at the moment are doing the work are under air pressure and there is no communication to the two idle paddles, and excessive leakage of air is thus avoided. After the air has done its work behind one of the paddles this paddle uncovers an exhaust port and the expanded air is allowed to pass out through the front end of the cleaner.

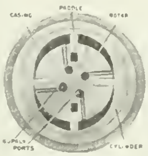


FIG. 2.

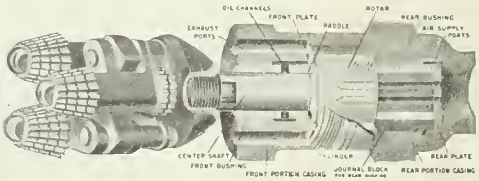


FIG. 3.

To permit the cleaner to operate economically under different air pressures, and in different hardnesses or thicknesses of scale, two interchangeable rear plates are provided with different port areas. The cleaner is of simple design and has few parts all made extra heavy to withstand the rough usage which such a tool must undergo. It is built for cleaning tubes from an inch to four inches in diameter, and a special design is suitable for use in curved tubes.

AUTOMATIC BOTTLE-MAKING MACHINE

An automatic bottle-making machine, invented and in use in Germany, is one of the triumphs of modern machine building. Doing the work of 250 expert glass blowers, it was considered such a menace to labor in Germany, where bottle-making is an industry of great magnitude, that the government is said to have limited its use by rather stringent rules.

The automatice making of bottles is accomplished through a great number of movable vacuum arms. A certain quantity of molten glass is drawn into the machine, air pressure is applied, and the glass is injected into an iron mold accommodating several bottles, then a device cuts the several bottles apart, the mold opens, and the bottles are automatically placed on a conveyor and transported to the cooling chamber. The machine can produce 2,000 bottles an hour.

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SCIENTIFIC MANAGEMENT AND THE ROCK DRILL

If we have in these days any considerable job of rock cutting or of rock excavation anywhere the most responsible and necessary item of the apparatus employed is the power driven—air, steam or electric-air—rock drill. Since its advent more rock has been removed from its native beds than in all the years of civilization before that, and the rate of rock removal and the quantities of rock to be removed increase with the years. The strenuous task of the drills and its rapid accomplishment has reacted upon its concomitants. It stirs all associated with it to a general hustle and still keeps itself ahead.

While the rock drill has been constantly developing into increased efficiency, the associate means connected with the handling of the materials liberated by it have not been able to keep pace with it. We might naturally have expected, as the drilling of the rock was the initiative operation and that which alone made all the other work possible, that the drill would be occupied most or all of the time, but really the drill has lots of standing around and waiting to do, hoists and cars and conveyors being employed more constantly. In the best records of tunnel driving that we have, say those of the Loetschberg tunnel, the actual working time for the drills was only two hours for each eight-hour shift. The drills, so far from holding back all the rest of the work, have really become the pacemakers in tunnelling and mining operations.

The fact is that what is now exploited as "scientific management," "motion study," "specialization of function," and the rest of it, were being developed, stimulated, promoted by the rock drill before these recent loud catchwords were thought of.

The drill itself has been improved in every detail and developed into types showing little relationship in design or in principle of operation to its earlier progenitor. The means of holding the drill securely when at work, so that it can be set quickly and fastened firmly and precisely and be pulled down and removed and brought forward and placed again by the average mine worker without baulk or delay, have been brought to great perfection. Then the selection of the bits and their maintenance have been given equal study, and the distribution and angle and depth and size of the holes, varying according to the dimensions and scope of the work, the hardness of the rock, the pitch of the strata, have all demanded special consideration.

The determining of the best explosive for each special case, the size of the charges to be used to best throw or to most completely shatter the rock, the sequence and manner of firing of the several shots, constitute another line of responsibility only to be satisfied by long training and experience.

After the explosion in mine or tunnel the ventilation expert has his task. This is first to so remove or dilute the gas laden air that men will be able to resume operations at the face, and then follows the general problem of ventilation, of so maintaining a standard of purity for the air that the health of all the workers will not be seriously affected. This is the subject of unending legal enactment, and no man knows to this day what should be known upon this important topic.

And all this is only preliminary to the final, work which the rock drill stands for, the getting and the removing of material, some of it merely to get it out of the way by dumping it in some other place, much of it to be used in various ways; from quarries for building or monumental purposes, from mines for its intrinsic values. In all cases the most onerous actual work, requiring the most power and taking the most time, is the hoisting and conveying of material. In this work of detailed transportation at the beginning and of general transportation farther along is the life work of great engineers.

POSSIBLE FRAUDS IN AIR COMPRESSOR TESTS

The Electric Review of recent date thus suggests how it would be possible for an air compressor builder to convey an incorrect impression as to the efficiency of his machine.

In conducting air compressor tests, it says, the method usually adopted is to measure the time taken to pump a reservoir of known capacity up to a given pressure, or to require the compressor to maintain a given pressure when the air is escaping through a sharp edged orifice of known size. In both cases the temperature of the air in the reservoir should be noted, and this cannot be measured by holding a thermometer in the issuing jet, when the orifice method of test is used.

When the output of a compressor is being gauged by the pressure maintained behind a sharp edged orifice, it is the inspector's duty not merely to measure the orifice, but to satisfy himself that there is no obstruction, temporary or otherwise, to the free flow of air to the orifice.

When the reservoir test is being conducted, the usual method of fraud consists in having a quantity of water in the reservoir, thus reducing its capacity and shortening the time required to raise the air it contains to the specified pressure. The presence of water cannot easily be detected if the drain cock is fitted with an internal pipe terminating at a point above the bottom of the reservoir, so that the air is always drawn from the cock when it is opened.

Another method, largely practical when there are duplicate reservoirs, as in battleships, consists of slightly opening a junction valve for a few minutes and allowing air from another reservoir to enter the one to which the compressor is connected. By this means the compressor is helped to the desired extent, and if the trick is carried out unobserved, it is difficult of detection, as the gage readings are not fine enough to make the transaction readily visible.

Compressor builders will doubtless be duly grateful to their electric co-workers for these business suggestions.

COMPRESSED AIR EXPLOSION WITH THERMOMETER RECORD

BY WILLIAM L. AFFELDER.*

While compressed air at high pressure has proven very satisfactory as a motive power in coal mines in which the use of electricity was not feasible, its use has not been entirely without fatalities. The dangers resulting from personal contact with conductors has, of course, been absent, but the use of compressed air has been attended by fatal accidents due to the disruption of parts of compressors or air lines, especially such parts of lines as were located adjacent to compressors.

This article is not a serious analysis of the theoretical points involved in such explosions, but is intended to display some data upon an actual explosion. While the writer was superintendent of the Redstone plant of the H. C. Frick Coke Co., at Brownfield, Pa., a vio-

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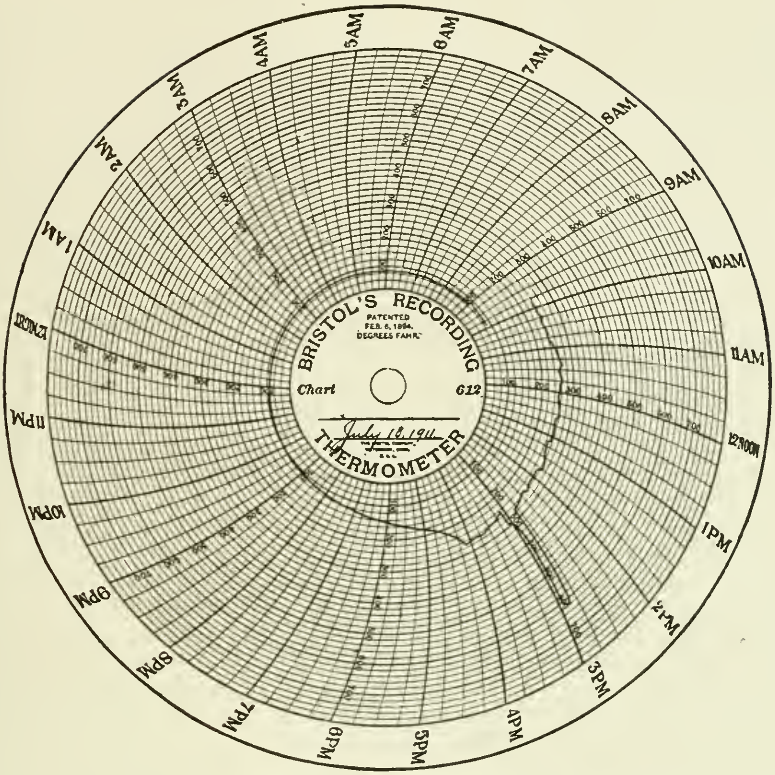
*General Manager, Bulger Block Coal Co., Bulger, Pa.



SUDDEN JUMP IN THE RECORD.

lent explosion occurred on May 31, 1909, in the 5-inch discharge pipe of a four-stage Laidlaw-Dunn-Gordon air compressor which was producing air at 1,000 pounds pressure for two air locomotives. A hole larger than a man's head was blown in the piping within the compressor room, but fortunately no more serious damage was done than the blowing out of all of the windows of the building. The engineer was working about the compressor at the time, but was not injured.

The compressor was not damaged, and was restarted as soon as a new piece of pipe was put into the line. Several other compressor explosions occurred at about the same time at plants of other companies in the Connellsville region with fatal results.

The fact that the walls of the compressor room were liberally spattered with oil after the explosion, led to the belief that the explosion was, to a considerable extent at least, due to the use of an excessive quantity of oil. An investigation of the question of oil consumption bore out this conclusion, as it showed that the monthly consumption of compressor oil had been 52.2 gallons in 1908 and 12 gallons per month in 1909 up to the time of the explosion. The much smaller quantity in the latter period was due to the fact having been recognized that far too much oil had previously been used, but later observations showed that the reduction had not been sufficient.

While excess of oil in the cylinders and pipes was thought to have been the main cause of the explosion, it was thought that the direct cause of the ignition was the imperfect action of the fourth-stage valves of the compressor. It was not until more than 2 years later that corroborative evidence of a very interesting character was obtainable, perhaps the only positive internal record of the kind in existence.

Shortly after the original explosion, there was installed in the compressor house a Bristol recording thermometer especially designed to record continuously the temperature of the air at the point where it passed from the compressor into the pipe line. By noting the temperature of the discharged air, the engineer was enabled to detect, in a measure at least, any serious defective operation of the compressor valves, for it soon became evident that, under normal conditions, the temperature of the discharged air should not exceed 250° Fahrenheit, although it seldom exceeded 240.°

As a further precaution, a fusible plug was placed in the discharge line near the compressor. This plug was made to blow out at a temperature of between 325 F. and 350° F. It might be added that these plugs, which have been patented jointly by Thomas McCaffrey, general manager of the Brier Hill Coke Co., and C. B. Hodges, of the H. K. Porter Co., are very extensively used, and have in numerous instances given evidences of internal conditions of such a nature that serious results would have occurred had it not been for the warning which they imparted. As a further precaution against explosions, the use of compressor oil was reduced to only 3.72 gallons per month throughout 1911, as a solution of castile soap and water was used almost exclusively for internal lubrication, with very satisfactory results.

The temperature chart for July 17, 1911, showed that the compressor was acting normally in every way. It showed a maximum temperature of but a trifle over 240 degrees F. at 12.20 a. m., after which it dropped to 220 degrees at noon, and registered 190 degrees and 230 degrees during the remainder of the day. The compressor was shut down at 4.45 p. m., and was restarted at 3.45 the next morning. Between 8 and 9 a. m. the temperature reached 250 degrees, but had dropped to 240 degrees when the chart for July 18 was put on the dial. This chart is reproduced in Fig. 1, and is worthy of very careful study.

It will be seen that by 11 a. m. it was evident that something was wrong with the internal mechanism of the compressor, for the temperature had crossed the 250 degree mark and continued to rise until it almost reached 270 degrees shortly after 11.15. The engineer did not fail to detect the rise in temperature, and upon investigation discovered that the fourth-stage discharge valves were not working satisfactorily, resulting in air working back from the air line into the fourth-stage cylinder. This "churning" of the air was producing heat more rapidly than the cooling water could accommodate. The engineer thought that, by careful running, he could finish the day, as the next day was to be a "lay-off day," and that he could then put in new valves or seats, or both, if necessary. He did not even consider the condition of the compressor as sufficiently serious to report the trouble to the master mechanic. He held the temperature between 250 degrees and about 265 degrees until almost 3 o'clock in the afternoon, when an internal explosion occurred.

The chart shows that this took place at 2.50, at a time when the temperature was slightly above 270 degrees. Coincident with the explosion the fusible plug melted and blew out, releasing the tension and checking the temperature at 620 degrees F. The compressor was immediately shut down and a new plug was put in, taking about 15 minutes, during which interval the temperature dropped to 245 degrees. The engineer then restarted the compressor, in which action he assumed an unnecessary risk, for the temperature again ascended to 270 degrees before it was shut down at 4.10 p. m.

After the defective valves and seats had been replaced with new ones, the compressor was put in operation on the 20th, and the chart for that day showed temperatures between 220 degrees and 240 degrees, but seldom as high as the latter figure, showing conclusively that the explosion was due to the churning of the air and that it was caused by leaking valves. The writer does not doubt that the warning imparted by the chart and the release of pressure afforded by the fusible plug averted a more serious explosion, although the practice of using soap solution and so little oil as was used, would likely have prevented an explosion of great magnitude.—*Mines and Minerals.*

NOTES

Gas Analysis as an Aid in Fighting Mine Fires. This is the title of Technical Paper 13, recently issued by the Bureau of Mines, which may be obtained free upon application to the Director, Bureau of Mines, Washington, D. C.

The number of passengers carried annually in the surface, elevated and subway lines of New York City exceeds by sixty per cent. the total number carried on the steam railways of the entire country.

A recent invention of some interest to motorists is that of a material called "Verre Souple" (flexible glass). It is said to be practically as transparent as glass, neglible in weight, unbreakable and suitable for wind-shields, windows, etc.

Casiano well No. 7, of the Huasteca Petroleum Company of Mexico, is said to be the greatest oil well in the world. For the last 17 months it has produced 11,000,000 bbl. under steadily increasing pressure, and now its average daily output is 25,000 barrels.

John R. Howells, of Plymouth, Pa., widely known as a manufacturer of drills, principally of the types used in coal mines, died May 27, sixty-seven years old. He began making his drills in 1878, and the plant he established is now operated by F. B. Spry. Mr. Howells lost a leg several years ago.

A mine telephone, required by a state law recently passed in Kansas, probably saved the lives of two shot firers employed in a mine near Pittsburg in that state. The men were cut off from the entry shaft by a gas explosion and telephoned to the top their location. A rescue party found both men unconscious, but after they were brought out they revived.

In a plant using compressed air through 60 ft. of hose for riveting, trouble was experienced in holding the pressure during the final setting of the rivet, the edge of the head becoming cold and not hugging snug to the plate. A bigger cylinder on the riveter did no good, but a receiver close to the riveter and a big connection pipe to the riveter remedied the trouble, providing sufficient air to follow up the riveter piston with little drop in pressure.

Liquefied gas will be manufactured in Kansas City, Mo., within the next year for distribution in western Missouri and Kansas and will be offered in competition with the natural gas in Kansas City if the prices there are increased, as planned. A $3,000,000 southwestern corporation, with a West Virginia charter, is considering the purchase of one of six sites in Kansas City for the manufacture of liquefied gas. It is one of eight similar corporations organized to build plants in different parts of the country.

Over 300 vessels are now afloat or under construction propelled by Diesel oil engines. This number includes 115 submarine torpedo boats, 30 other naval vessels, and a number of freight and passenger merchant vessels of 1200 to 3000 hp. France has over 60 submarine boats equipped with this engine. The United States has two just completed. The Diesel engine can use not only petroleum oils but tar oils, and oils produced by the distillation of lignite and shale. It has the highest fuel efficiency of any commercial heat engine.

A Manchester engineer has patented an apparatus which, it is claimed, will prevent the clouds of dust raised in dry weather by automobiles and other vehicles. The device, which is simple and inexpensive, collects the dust as it rises. The dust is drawn into conduits which are funnel-shaped at the mouth and which run from the rear of the front wheels to the rear of the back wheels. These conduits are connected with a box into which the dust is driven by the pressure of air, or this end can also be accomplished by the aid of a centrifugal fan geared to the driving shaft of the automobile. The contents of the dust box can be discharged by pulling a lever at the front of the vehicle.

In the northern part of Minnesota there is a great area of land so flat that its waters sometimes flow into Hudson bay and sometimes into the Gulf of Mexico. This area contains the headwaters of the Mississippi river. There are times when certain lakes discharge at both ends, the northern outlet taking the flow through Red river or Rainy river into Lake Winnipeg, and thence into Hudson bay; while the southern outlet leads to the Mississippi. From the same neighborhood water flows also to Lake Superior, and so over Niagara and down the St. Lawrence to the Atlantic.

A letter received some years ago by the Westinghouse Machine Co. said that the writer had been using one of its standard vertical engines with eminent satisfaction. For eight years it had been in continuous service night and day, handling its load without a hint of trouble, but that "upon shutting it down the other evening it went all to pieces." The letter was passed to the eminent inventor whose name the company bears, and handed back with the remark: "Ask the blamed fool what he shut it down for."

In driving the Laramie tunnel in Colorado the average depth of hole was 17½ ft.; a stick of 60 per cent. powder was placed in the bottom of the hole; then the primer, on top of which five sticks of powder were used except in the case of cut holes, each of which were loaded with three or four extra sticks. The three lifters were loaded to the collars in order that the broken ground should be thrown as far as possible from the face.

A physician in Dubuque, Ia., Dr. J. H. Schrupp, has found that the ordinary vacuum bottle provides a quick and sure way of growing microbes. He secured some of the inflamed tissue from a patient's throat upon absorbent cotton, placed it upon gelatine, and put it into the vacuum bottle, which had been filled with hot water at incubating temperature and emptied. He then found that he could grow the germs much more conveniently, with more cleanliness, and very much more rapidly than the health department was doing. Since his discovery he has reduced the time for diagnosing diphtheria, tonsilitis and typhoid fever from two and three days to five and ten hours.

While in Africa, Marconi accidentally made a discovery which is of the greatest importance. During some experiments in the desert he was surprised and gratified to find that wireless messages could be sent with absolute security over the desert without the usual masts Instead of poles, wire is laid on the sand in the direction in which the message is to be sent. It goes and is received without any interruption exactly the same as though the usual system were employed. This is made possible by the fact that the sand is an absolute non-conductor, so electric waves are not disturbed in any way. The sand being dry, neither rain nor tempest can affect the waves.

An oil engine exhaust muffler is used in the sewerage power station at Fairhaven, Mass., where a Hornsby-Akroyd engine drives an air compressor. The 5-in. exhaust is connected into one end of an 8-in. cast-iron pipe, which happened to be on hand. The pipe is made up of two lengths of 12 ft. each, and its outer end is led into a pit of field stones having a channel somewhat wider than the diameter of the pipe and about 30 in. deep and 10 ft. long. Some discarded boiler tubes were laid across the channel and on these stones were piled to a height of about 3 ft. The cooling water was led into the cast-iron muffler near the cylinder. The noise of the exhaust is muffled in the interstices between the stones.

Within a recent decade the farm area in the South devoted to peanut culture increased from 515,880 acres to 869,280 acres, or more than 68 per cent.; the crop, from 11,942,000 bushels to 19,404,000 bushels, or 62 per cent., and the value of the crop from $7,251,000 to $18,257,000, or 151 per cent. The average value per acre of the peanut crop of 1909 was $21 while the average acre value of other crops in the same year were wheat, $15.63; corn, $15.19; hay, $15.07; buckwheat, $14.61; flaxseed, $14.39; barley, $13.40; oats, $12.29, and rye, $11.87. It will thus be seen that the acre value of peanuts approached the class of rice, which averaged $26.85 an acre, and of cotton, which, with its seed, averaged $29.32 an acre.

Experiments are under way at the agricultural bacterioligical station at Vienna to increase the quantity of iron carried in certain plants, with a view to the effect on the human system when those plants are used as food. Artificially prepared foods containing iron do not always produce the desired effect, because the iron is not completely assimilated. This difficulty, it is thought, may be avoided by causing plants to take up an increased quantity of iron during their natural growth. By adding hydrate of iron to the soil in which it was growing, the experimenters have succeeded in producing spinach containing a percentage of iron seven times as great as that found in ordinary spinach. It is believed that the process will prove successful with other ferruginous plants.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 7.

1,025,132. AUTOMATIC GUN OR RIFLE. WILLIAM M. DOUGLAS, Galveston, Tex.

2. In a fire arm of the character described, a barrel, a gas-cylinder having communication with the barrel and receiving gas therefrom on discharge, a piston operating within the gas-cylinder, *an air compressing cylinder*, a plunger operating within said air compressing cylinder, means

connecting the piston and plunger, a breech-bolt carrying an extractor and cooperating with the barrel, an element for locking the breech-bolt in its closed position, mechanism actuated by compressed air from the air compressing cylinder for operating said element, and means actuated by such compressed air for moving the breeçh-bolt after the same is unlocked.

1,025,135. PNEUMATIC PIANO - PLAYER. Charles Freborg, Kankakee, Ill.

1,025,191. CARTRIDGE FOR THE PREPARATION OF OXYGEN. George Francois Jaubert, Paris, France.

1. A cartridge for the preparation of oxygen or gaseous mixtures rich in oxygen comprising an envelope made of a combustible metal and filled with a pulverulent mixture containing a combustible substance and a substance substantially as described which when heated will give off oxygen to unite with the combustible substance and an excess of free oxygen, said pulverulent mixture being in direct contact with the metallic envelop, and said envelop having removable end covers, whereby the envelop serves for the tranportation of the mixture and also as a container during combustion.

1,025,199. CAN-TESTING MACHINE. Charles B. McDonald, Chicago, Ill.

In a can testing machine, the combination of testing mechanism, a housing therefor, an air chamber in conjunction therewith, a source of pressure supply, a slidable tapered valve controlling communication between the source of pressure supply and the air chamber of the testing mechanism, including a member having a tapered seat for said valve, a tension member for normally maintaining said valve in wedging engagement with its seat, and means for periodically sliding and unseating said valve to permit the passage of air from the source of pressure supply to the air chamber, said tension mechanism effecting a quick return of said valve to normal position, substantially as described.

1,025,221. HAND - OPERATED AIR - PUMP. Frank C. Virtue, Toronto, Ontario, Canada.

1,025,222. LIQUID-PRESSURE REGULATOR. Joseph D. Wallace, Champaign, Ill.

1,025,236. VIBRATOR. Henry Behm, Jersey City, N. J.

1,025,297. LIGHT AND LOAD BRAKE APPARATUS. Robert A. Parke, Parke Mines, Ontario, Canada.

1. In a light and load brake apparatus, the combination with the device for limiting the fluid pressure in the brake cylinder when the brakes are applied, of means controlled by the weight of the load for cutting said device into or out of operation.

1,025,310. AUTOMATIC AIR-CURRENT-ACTUATED ALARM. Louis Robillot, Besancon, France.

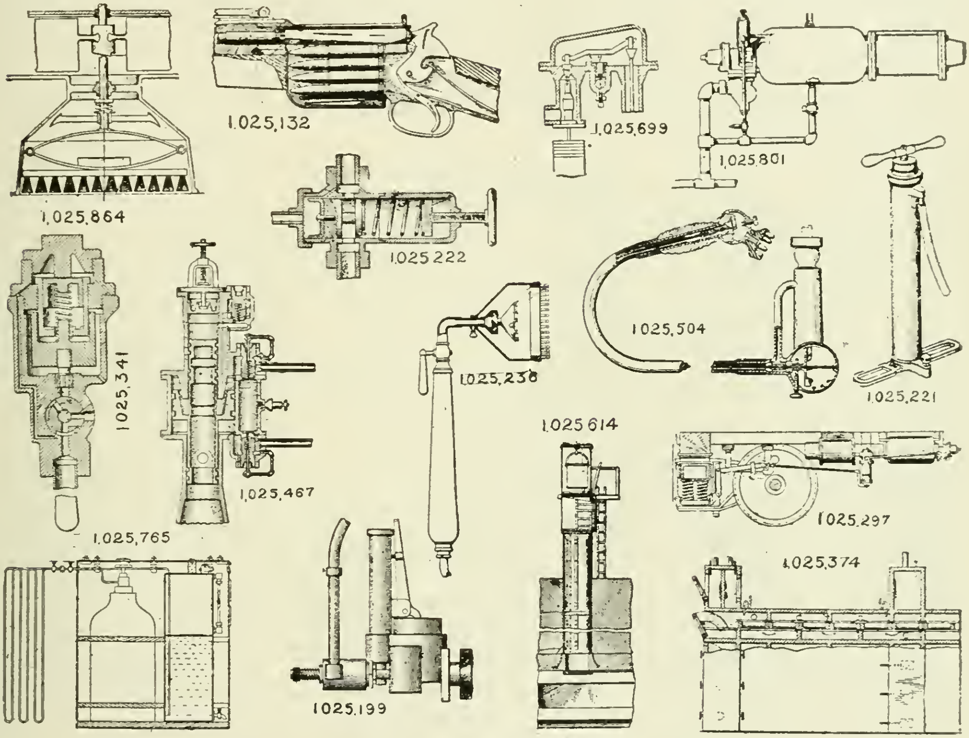
1,025,340. FLUID-PRESSURE-CONTROL APPARATUS. Walter V. Turner, Edgewood, Pa.

1,025,341. RETAINING-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1. A pressure retaining valve device for the brake cylinder of a fluid pressure brake system comprising a loaded valve and fluid pressure operated means for varying the load on said valve to thereby retain different degrees of pressure in the brake cylinder.

1,025,374. PROCESS OF DEHYDRATING ANIMAL AND VEGETABLE SUBSTANCES. Ernest William Cooke, New York, N. Y.

1. The process of dehydrating succulent food substances without injuring their cell structure or texture, which consists in subjecting pervious masses of such substances to the dehydrating action of a flowing current of air in moisture absorbing condition passed through such masses in a chamber maintained under pressure, said air



Pneumatic Patents, May 7.

being at a temperature too low to produce chemical changes in said succulent food substances and the air initially used in treating said substances containing some moisture, whereby the water is removed from them with substantially no loss of other substances and they are left in a condition such that they can be restored to their original undehydrated condition simply by the addition of water.

1,025,467. PULSATING APPARATUS. Fred D. Holdsworth, Claremont, N. H.

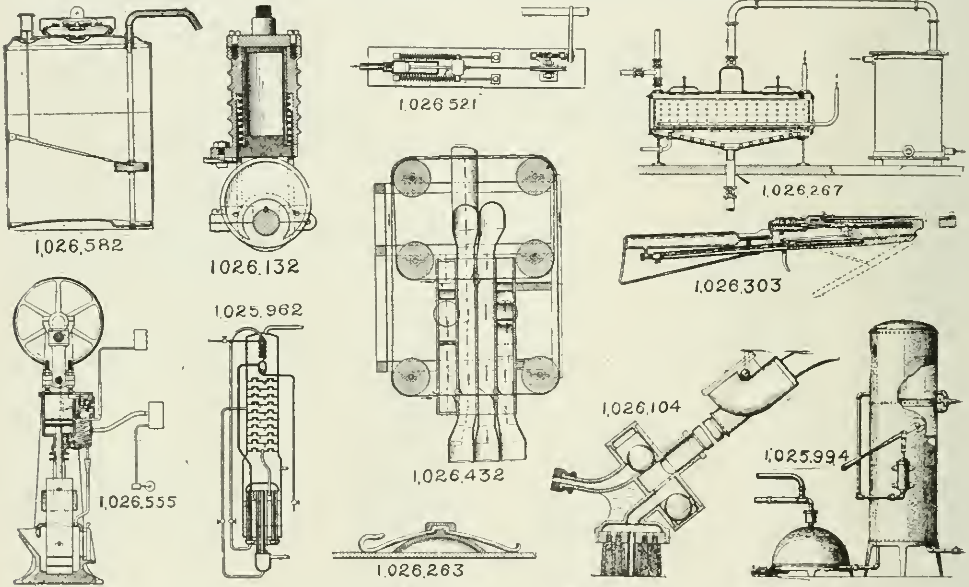
1,025,504. COMBINED VIBRATOR AND VACUUM APPARATUS. James Birrell and William Birrell, Seattle, Wash.

1,025,614. CAISSON. Oliver Cromwell Edwards, Jr., Troy, N. Y.

1,025,699. APPARATUS FOR RAISING LIQUIDS BY COMPRESSED AIR. Paul Kestner, Lille, France.

1,025,765. REFRIGERATING APPARATUS. Joaquin Garcia de Quesada, Barcelona, Spain.

1. In a refrigerating apparatus provided with a cooling coil, the combination of a portable generator comprising a container for gas under pressure and a closed receptacle divided by an apertured partition into a lower compartment for normally containing an absorbent of such gas and a communicating upper overflow compartment, a water glass on said overflow compartment, a valved pipe communicating with the lower portion of said lower compartment, a valved pipe leading from said container, and means for detachably securing said container pipe and lower compartment pipe respectively to the inlet and outlet of the coil.



Pneumatic Patents, May 14.

1,025,801. AIR-BRAKE. Jesse B. Gardner, Charleston, S. C.

1,025,864. VACUUM-CLEANER. Dallas J. Cogdill, Spokane, Wash.

MAY 14.

1,025,962. METHOD OF EXTRACTING RARE GASES FROM THE AIR. George Claude, Paris, France.

1. A process for separating rare gases from the atmosphere which consists in bringing cold compressed air into indirect contact with liquid oxygen or liquid rich in oxygen, thus liquefying the greater part of the oxygen and of the nitrogen of the air and causing the gaseous residue of this liquefaction to partially liquefy by circulating it in indirect contact with liquids rich in nitrogen and in oxygen.

1,025,994. VACUUM CLEANING SYSTEM. John R. Pettiford, St. Louis, Mo.

1,026,104. PNEUMATIC SCRUBBING APPLIANCE. Albert E. Moorhead, San Fracisco, Cal.

1,026,132. AIR-COMPRESSOR. William R. Thompson, South Norwalk, Conn.

1,026,193. RELIEF-VALVE FOR PNEUMATIC CLEANING SYSTEMS. Morris S. Wright, Worcester, Mass.

1,026,263. VACUUM SUPPORTING DEVICE. Ross Hazelrigg, Oakland, Cal.

1,026,267. PROCESS FOR RENOVATING COTTON-WASTE. Julius Kauffmann, Berlin, Germany.

The herein described process of renovating solid cotton waste, consisting in washing the same with a volatile solvent liquid and blowing compressed air through the liquid to agitate the waste, evaporating the solvent by the action of heat and simultaneously blowing compressed air through the waste to prevent packing, and finally drying the waste and blowing off dust by the action of compressed air.

1,026,303. REPEATING AIR-RIFLE. Arthur V. Dickey, Seattle, Wash.

1,026,371. VACUUM-CLEANER. Walter T. Smith, Jackson, Mich.

1,026,412. TUNNELING-MACHINE. Richard T. Stone, Deming, N. Mex.

1. In a tunneling apparatus of the kind described, an extended cylindrical shell formed with compartments accessible to one another, the forward end of said shell having a cylindrical cutting edge, means for compressing air in said compartments, a longitudinal rotary tube having its forward end projecting from the forward end of said shell and provided with a cutting head, and inlet apertures, mechanism for rotating said tube, and means for discharging water at the forward end of said shell.

1,026,432. PNEUMATIC FEATHER-CLEANING APPARATUS. Charles V. Dey, Chicago, Ill.

1,026,521. AIR-COMPRESSOR. Andre Henri Marcou, Versailles, France.

1. In an air compressor, the combination of a

piston, a heavy body secured on the piston rod, an elastic device for throwing forward said piston and its body, a device for stretching the elastic device and a releasing device for allowing said elastic device to suddenly unstretch.

1,026,553. VACUUM-CLEANER. LONNIE A. BAXTER, Cincinnati, Ohio.

1,026,555. PNEUMATIC PERCUSSIVE APPARATUS. HANS CHARLES BEHR, Johannesburg, Transvaal.

1,026,582. DISPENSING-CAN. CHAUNCEY A. HERTENSTEIN and WILLIAM F. PROBST, Chillicothe, Ohio.

1. A dispensing can comprising a tank, a discharge pipe, an air compressing device on said tank for forcing air thereinto, and means for admitting the air under pressure to the said pipe near its mouth to simultaneously cut off the flow of liquid and exhaust the compressed air.

MAY 21.

1,026,656. CAISSON. RALPH H. CHAMBERS, New York, N. Y.

in the melting chamber, substantially as and for the purposes described.

1,026,756. PROCESS OF TREATING MILK. JOHN MCINTYRE, Jersey City, N. J.

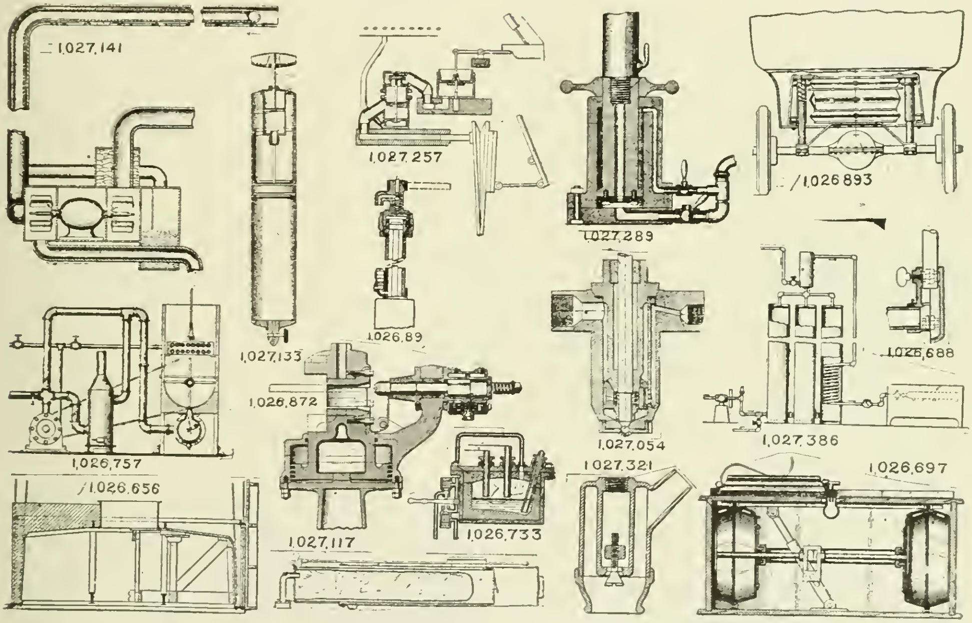
1,026,757. APPARATUS FOR DRYING MILK. JOHN MCINTYRE, Jersey City, N. J.

1. An apparatus for drying milk, comprising a vessel for containing the milk and having an open top and a bottom semi-circular in cross section, the said bottom being provided with an air induction slot extending throughout the length of the bottom, an agitator in the bottom portion of the vessel sweeping the surface of the bottom portion, and an air supply connected with the said slot, for forcing a blast of compressed air through the slot into the milk, as set forth.

1,026,872. FLUID - CONTROLLED DRILL-STEEL-FORMING AND DRILL-BIT-SHARPENING MACHINE. JOHN GEORGE LEYNER, Denver, Colo.

1,026,891. HAND-RAMMER. FRANZ WEGNER, Halle, Germany.

1,026,893. PNEUMATIC CUSHION FOR VEHICLES. FRED I. BAKER, Orange, Mass.



PNEUMATIC PATENTS, MAY 21.

1,026,688. SAND-BLAST DEVICE. WALTER MACLEOD, Fort Thomas, Ky., and WILLIAM HEXT, Cincinnati, Ohio.

2. In a sand blast device, a sand collector, consisting of a pan and a cover for the pan, the pan projecting beyond the front edge of the cover, and thereby forming an air inlet port, a sand delivery port, and a port provided in said cover between said air inlet and said sand delivery port for admitting sand to said collector.

1,026,697. VACUUM ERASER-CLEANER. CLARENCE W. POLLEY, Skaneateles, N. Y.

1,026,732. APPARATUS FOR DISTRIBUTING FUEL IN INTERNAL-COMBUSTION ENGINES. HANS TH. BRUNS, Nuremberg, Germany.

1,026,733. PROCESS FOR CASTING METALS. FRANZ DE BUIGNE, Magdeburg, Germany.

1. In a process of casting molten metals under pressure, which consists in heating a metal bath internally, suddenly releasing the pressure established by an indifferent gas so as to produce by the rapid escape of the gases a partial vacuum

1,027,054. ATOMIZER FOR LIQUID-FUEL MOTORS. JOSEPH LEFLAIVE, St.-Etienne, France.

1,027,060. PNEUMATIC HAMMER. REINHOLD A. NORLING, Aurora, Ill.

1,027,061. AUTOMATIC THROTTLE-VALVE-LOCKING MECHANISM FOR PNEUMATIC TOOLS. REINHOLD A. NORLING, Aurora, Ill.

1,027,062. PNEUMATIC HAMMER. REINHOLD A. NORLING, Aurora, Ill.

1,027,117. VACUUM-CLEANER. WILLIAM R. FOWLER, Baltimore, Md.

1,027,133. FIRE-EXTINGUISHER. ERNEST M. LAWRENCE, New York, N. Y.

1. A device of the character specified, including in combination, an elongated casing, an air-compressor mounted at one end of said casing and including a compression-chamber within said casing, a piston working in said chamber, and valves communicating therewith, and a floating material-expelling member slidably disposed in said casing independently of said air-compressor and movable under the influence of the compressed medium produced by the said compressor.

1,027,141. AIR-TEMPERING DEVICE. Frank P. Mies, Chicago, Ill.

1,027,257. PNEUMATIC ACTION FOR SELF-PLAYING PIANOS. Walter A. Kruck, Camden, N. J.

1,027,288. CUSHIONING DEVICE FOR VEHICLES. John C. Sherman, Brookline, Mass.

1,027,289. RIVETING - MACHINE. Edwin Smith, Viau Ville, Montreal, Quebec, Canada.

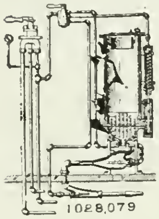
1,027,321. HYDRAULIC AIR-EJECTOR. Ernest E. Cleveland, Springfield, Mass.

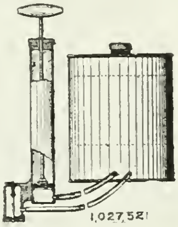
1,027,386. HYDRAULIC FLUID-COMPRESSOR. Alda F. Hawkins, Dallas, Tex.

MAY 28.

1,027,461. AIR-GAGE. Joseph A. Buttress, Los Angeles, Cal.

1,027,462. AIR-PROPELLED CAR-FAN. John L. Council, James E. Tharpe, and Thomas M. Dale, Statesville, N. C.


1,028,079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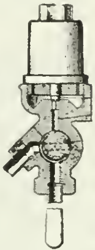
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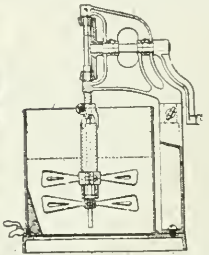
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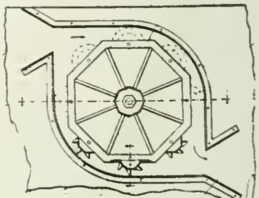
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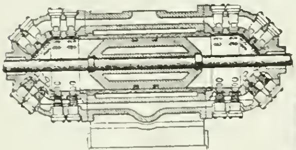
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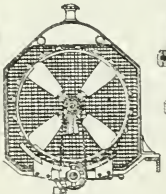
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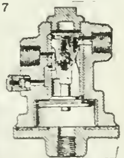
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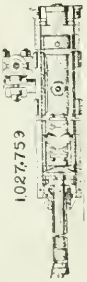
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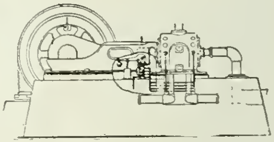
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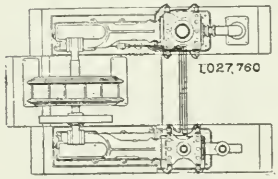
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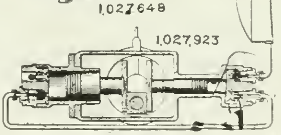
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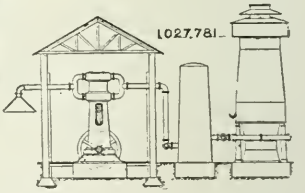
1,027,781

Pneumatic Patents, May 28.

1,027,493. FLUID-OPERATED CLUTCH. John R. McGiffert, Duluth, Minn.

1,027,521. SPRAYING DEVICE. Henry E. Brandt, Minneapolis, Minn.

1,027,531. AERATING BUTTER-SEPARATOR. Alpheus Fay, Louisville, Ky.

1,027,648. ENGINE-STARTER. Edwin Guthrie, Washington, D. C.

1. In an engine starter, the combination with an engine having an engine shaft, of a revoluble fan arranged to cause air to flow over the engine to cool the same, the said fan having a series of buckets, means constructed to transmit the movement of the engine shaft to the fan and the movement of the fan to the engine shaft, a fluid storage tank, a member having jet nozzles directed toward the buckets of the fan, and tubular connections including a cut-off valve and arranged between the tank and said member.

1,027,695. CLAMP FOR FLASKS. Edson C. Covert, Chicago, Ill.

1. A clamp comprising, in combination, a support, a clamp member rotatably and slidably connected to said support, a reciprocating member arranged to act upon said clamping member, and fluid pressure means for actuating said reciprocating member, substantially as described.

1,027,757. UNLOADER FOR FLUID-COMPRESSORS. William Prellwitz, Easton, Pa.

1,027,758. UNLOADER FOR COMPOUND FLUID - COMPRESSORS. William Prellwitz, Easton, Pa.

1,027,759. SUPPORT FOR MINING TOOLS OR MACHINES. William Prellwitz, Easton, Pa.

1,027,760. UNLOADER FOR FLUID-COMPRESSORS. William Prellwitz, Easton, Pa.

1,027,781. APPARATUS FOR SUPPLYING AIR TO BLAST-FURNACES, CONVERTERS, AND THE LIKE. Ralph H. Sweetser, Columbus, Ohio.

1,027,817. LIQUEFACTION OF GASES. George Claude, Paris, France.

1. The method of liquefying permanent gases which consists in subjecting a compressed and cooled permanent gas to the indirect cooling action of another expanded permanent gas with a lower critical temperature, the remaining cold of which after being utilized for liquefying purpose is used in cooling both compressed permanent gases the one to be liquefied and the other to be expanded.

1,027,823. APPARATUS FOR TESTING AIR. Robert Henry Davis, London, England.

1,027,841. FLUID-COMPRESSOR. Harry D. Hildebrand, Pittsburgh, Pa.

1,027,862-3. APPARATUS FOR THE SEPARATION OF HYDROGEN FROM A GASEOUS MIXTURE. Carl von Linde, Munich, Germany.

1,027,923. AIR-PUMP. Gregory John Spohrer, Franklin, Pa.

1,027,937. EXHAUST-CONTROL VALVE FOR AIR-BRAKES. Walter V. Turner, Edgewood, Pa.

1,027,938-9. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,027,987. PRESSURE-RETAINING VALVE. Thomas L. Burton, Elizabeth, N. J.

1,028,073. AIR-HEATING APPARATUS. Albert Edward Jones, Fiume, Austria-Hungary.

1,028,079. AIR TRACK-SANDING APPARATUS. William A. Sault, Worcester, Mass.

1,028,080. AIR-PUMP. Charles F. Snyder, Allegheny, Pa.

COMPRESSED AIR
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EVERYTHING PNEUMATIC.

Vol. XVII AUGUST, 1912 No. 8

HOW AN AIR RECEIVER EXPLODED

BY FRANK RICHARDS.

A small air receiver connected with a portable gasolene-engine-driven air compressor employed on street gas pipe work exploded on June 24th, near the entrance to Greenwood Cemetery, Brooklyn, the occurrence exhibiting a number of interesting features illustrative of the conditions under which such accidents may occur.

To save time it may be premised that circumstances, after the event, indicate that this was not a typical explosion of the type which we are apt first to think of in such cases. There seems to have been no sudden and enormous increase of pressure, such as would be caused by the ignition of an explosive mixture composed of volatilized constituents of the oil combined in suitable proportion with the compressed air. The normal working pressure which the receiver usually carried was probably not much, if at all, exceeded, nevertheless it seems to have been ultimately a simple pressure explosion, but accompanied by abnormal conditions which provided the opportunity.

The receiver was suspended horizontally under the frame which carries the gasolene engine and the compressor. It was 6 ft. long and 2 ft. in diameter with dished heads, the convex side of the head being outward at one end and the concave side outward at the other end, this being the too familiar practice just for convenience in riveting in the last head and for no other good reason. The air entered the receiver from the compressor about 2 ft. from one end of it and at the central height, and the air was taken out at the other side just opposite the inlet, see Fig. 1. A pop safety valve on the pipe leading from the compressor was set at 110 lb., and the usual working pressure was about 100 lb.

As disclosed after the explosion, the entire

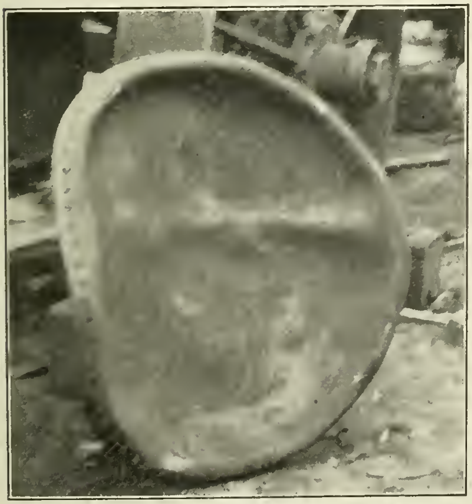

FIG. 2. THE HEAD THAT BLEW OUT.

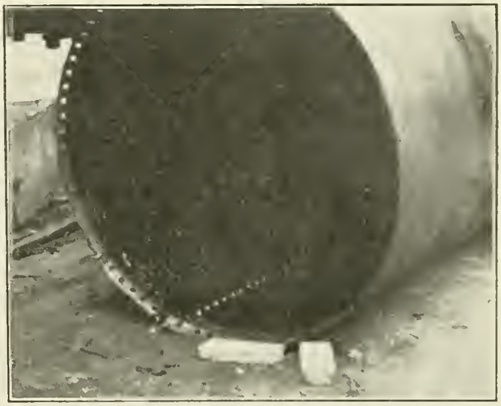

FIG. 3. END OF SHELL.

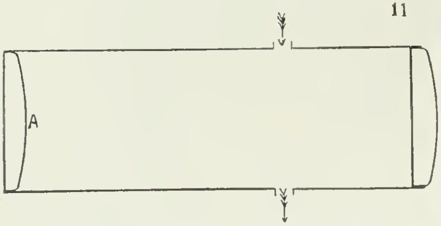

FIG. 1. PLAN OF RECEIVER.

interior surface of the receiver was covered apparently with all the oil it could carry. If the compressor runner had been told to use all the oil he could, instead of as little as possible, the surfaces probably could not have been more oily. It would have been proper of course to have drawn off from time to time all the oil and water which might have collected at the bottom of the receiver, and this may or may not have been done, but it evidently would not have made the surfaces clean or have freed them from the gummed or thickened oil with which they were coated.

The condition of the inner surface (A, Fig. 1) of the head which blew out, the head with the convex face inward, was as different from this as could be imagined. It was dry and absolutely clean, and the color and condition of it showed that it had been red hot. It was evident that a local fire had raged, perhaps only for a minute or so, on this then oil-coated surface, burning the oil off and suddenly heating the plate, the fire not having had time to spread to the adjacent surface of the cylindrical shell, and then the explosion came.

In the act of explosion several curious things happened which it is worth while to note carefully. The head became so hot that, as it was under about all the air pressure it could stand anyway, the dishing of the head was suddenly reversed, and the originally convex surface became concave, as Fig. 2 shows, this being a view of the inner surface. That this is the inner surface of the head is corroborated by the lip at the edge of the sheet. The ridge which is dented across the face was evidently caused by something against which the head struck, presumably the axle of the machine, as it flew off.

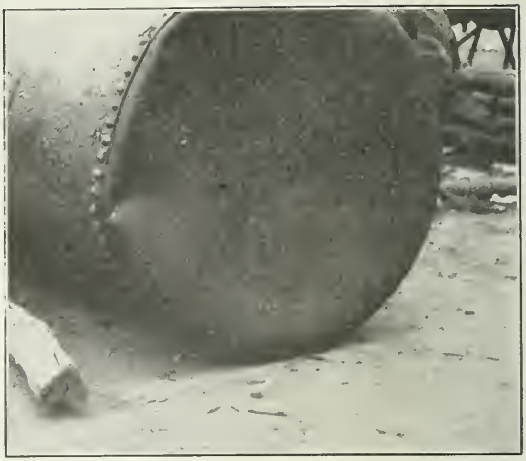

FIG. 4. OTHER END OF RECEIVER.

We can readily imagine that this reversal of the dishing of the head took place with considerable of a snap, the shock and momentum, in addition to the aggregated air pressure, 45,000 lbs., being sufficient to cause the head to let go.

When it did let go not a single rivet was sheared. It will be noticed in Fig. 2 that when the reversal of the dishing of the head occurred and the tearing-away-act was going on the rivet-carrying lip of the head was bent outward all the way around, so that the opposite sides, instead of being parallel, stood off 30 to 45 degrees from the normal position, the end of the sheet to which they were attached bending outward in the same way. See Fig. 3. There were 80 rivets, ⅜ in. diameter, and when the lip was bent out in this way these rivets just pulled their heads off, dropping them outside the shell all around, and then the rivets pulled out of the holes and the job was done. The fracture of the rivets was square across under the riveted heads and flush with the outside of the shell. Of the entire 80 rivets just 3 kept their heads on, and these took their leave of the shell by tearing notches out of it.

When the head flew off the body of the receiver naturally was driven in the opposite direction, but it could go only a few inches when it struck the axle of the machine which dented the head as seen in Fig. 4. Besides this the shell seems to have received no other damage.

Undoubtedly receivers have often taken fire internally as indicated in this case, but having a sufficient factor of safety notwithstanding the heating of the metal, they have been able to stand the strain and no accident has resulted;

nevertheless the occurrence is one which it is not pleasant to think of, and every precaution should be taken to prevent it. The interesting question is as to the conditions causing or accompanying these ignitions of the oily surfaces, and there is usually more or less of mystery made of this phenomenon when it occurs.

My thoughts carry me back to what was one of the familiar operations of the shop when I was every day in it, and that was the oil tempering of steel springs. The spring is first heated in the fire to a bright red and then is plunged into oil and cooled. This leaves it hard and brittle and it is drawn to the proper temper by "blazing off." To do this the spring while dripping with oil is held over the fire, which must be without flame, and is slowly and carefully heated until the oil on the spring bursts into flame. The oil is not ignited by the fire. There is no flame or spark from the fire that does it; the flame simply comes of itself, as we might say, when the spring reaches the right temperature. When the spring reaches this temperature the oil will keep burning until the oil is burned off, or the spring while blazing may be dipped in the oil and the flame will go out, but if the spring is quickly drawn out of the oil the flame will "light itself" again as before. There is a certain temperature at which the oil will ignite spontaneously, and this temperature is so fixed, differing, however, for different oils, that it has been taken for generations as an index of the heat required for the tempering of springs, swords and other responsible articles of steel.

Precisely the same thing that happens in the oil tempering of springs will happen to the oil coated surfaces of air receivers, pipes, etc., when they get hot enough. The oil will take fire of itself without the impulse of any spark or flame or other extraneous means of ignition. The oil-covered steel spring when the oil upon it takes fire in the open air is below a visible red heat, and that begins at about 700 degrees Fahrenheit. In the air receiver whose explosion we are here considering the temperature due to compression may have been as high as 500 degrees. With air when compression begins at a temperature of 60 degrees the theoretical terminal temperature after adiabatic compression to 105 lbs. is 496 degrees. This compressor was running in bright sunshine on a hot day and the intake air passed close to the already heated air receiver before entering the cylinder, so that its temperature at the beginning of compression was presumably above 100 degrees and its terminal temperature above 500 degrees. The fact that at this end of the receiver there was nothing to cause any active movement of the air in contact with the oily surface may have offered special opportunities for the atoms of carbon and of oxygen to make love to each other and consummate their union.

We must remember that with the air at 105 lb., gage, it is compressed to 8 atmospheres, which means that the molecules—if that's the word—of carbon in the oil are individually exposed to or in contact with 8 times the quantity of oxygen that they would be in contact with the air had only the normal pressure of 1 atmosphere, so that we may readily believe not only that the oil would be ready to spontaneously ignite at a lower temperature but that it would also burn more fiercely after the ignition.

There recently appeared in *Mines and Minerals,* reprinted in COMPRESSED AIR MAGAZINE, June, 1912, an account of an ignition of this character, but without damaging explosion, in connection with a four-stage compressor employed for charging mine locomotives. The ignition occurred after the fourth stage of the compression, when the air was at a pressure of 65 atmospheres, and a recording thermometer which was providenially attached and in operation showed that the ignition took place at 270 degrees, which seems to corroborate our assumption that the higher the pressure the lower will be the temperature at which spontaneous ignition will occur.

This article purposely avoids all discussion of the type of compressed air explosions, usually more forcible and destructive, caused by the firing of an explosive mixture of compressed air with some of the volatilized constituents of the lubricating oil, nothing of this apparently having occurred in the case here considered.—*Power.*

The three deepest bore-holes in the world are now claimed to be in Prussia. One near Paruschovitz, in the Rybuik district, is 6573 feet deep; one at Schubin, in the province of Posen, is 7052 feet, and a third near Czuchow is 7348 feet.

MEASURING AIR CONSUMPTION

BY GEORGE H. GILMAN.*

The science known as efficiency-engineering is, in some of its aspects, merely the application of ordinary common sense to the problem at hand. When purchasing rock drills or hammer drills, for example, it is often desirable to conduct tests upon several makes or types, to determine their relative efficiency for the work in hand. One of the tests which it is important to make is that for air consumption, in order to arrive at the quantity of power used per foot of hole or per cubic yard of rock removed. This is a factor too often left to guesswork, or ascertained only roughly.

Extended experiments have shown that the displacement tank method is as accurate as, and probably more reliable than, the special mechanical air meters which have been devised at various times.

A satisfactory apparatus for this purpose is shown in the accompanying illustrations. It consists of two large vertical tanks, so arranged that they may be filled with air at any desired pressure. The drill to be tested is connected to one of these tanks, the tanks are filled with air at the proper pressure, and the large steam pump, shown at the left of Fig. 1, is started. The height of water in the gage glass is noted, and the drill started working. The air pressure in the tank is kept constant by the admission of water from the pump. After a run of sufficient length to secure accuracy, the drill is stopped, and the height of the water in the gage glass is again noted.

The increase in volume of the water in the tank is the amount of air used by the drill during the run, and from this the cubic feet of free air used per minute many be figured.

Two tanks are supplied, so that one may be used while the other is being filled with air, thus allowing tests to be run over a considerable period of time.

The sketch, Fig. 2, shows a type of displacement apparatus, at present used successfully by various mining companies. This is much less expensive than the apparatus with pump and reservoir, and will meet the requirements of any mine or quarry to practically as good advantage, although possibly, it is not quite as accurate.

Two small tanks, say about two feet in diameter and four or five feet long, are connected together at the bottom by a pipe of good size, say three inches, and about half filled with water. Gage glasses for observing the water level are attached to each receiver. Out of the top of each receiver is brought a pipe and connected to a four-way valve. When the valve is set in the position shown by the full line, water in the right-hand tank will be forced into the left-hand tank by the air pressure, and the air in the latter tank will be driven out and passed through the four-way valve to the drill or other machine being tested. When the water arrives at a definite point on the upper end of the gage glass on the left-hand tank, the four-way valve is quickly thrown to the position shown by the dotted line, when the process will be reversed and the air in the right-hand tank will be driven out and passed to the machine under test. By counting the number of times each tank is filled or emptied during a given interval of time, it will be seen without further explanation that the amount of air consumed by the machine under test can be determined by reducing to cubic feet of free air the volume of air under pressure which has been displaced.

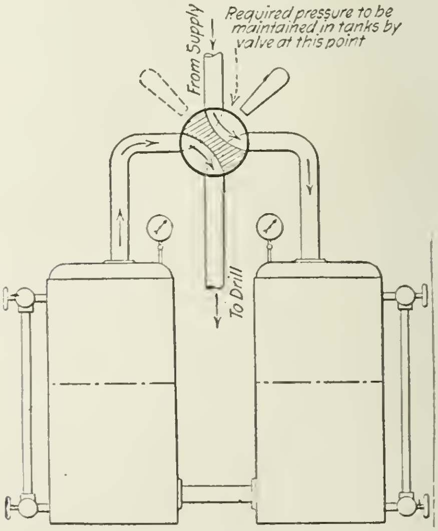
From Supply
Required pressure to be maintained in tanks by valve at this point
To Drill

FIG. 2.

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*Claremont, N. H.

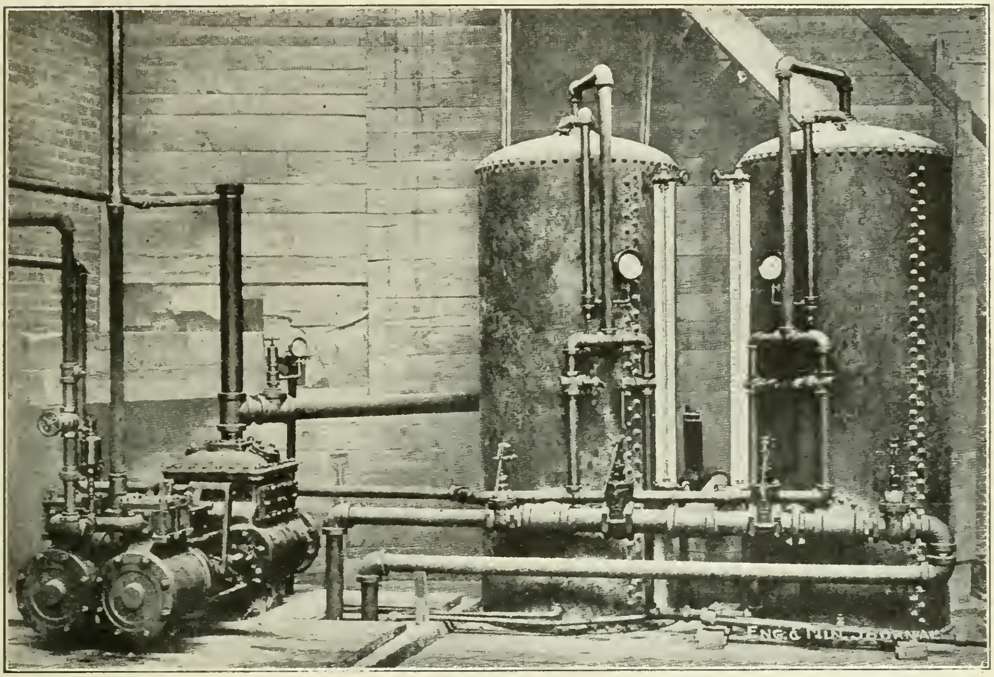

FIG. 1. MEASURING AIR CONSUMPTION. (*See opposite page*).

A PNEUMATIC HELICOPTER

An account of a new helicopter was recently presented to the Academie des Sciences by Messrs. Papin and Rouilly. They call it a "gyropter" and it is propelled by compressed air sent into the propeller so as to drive the latter by its escape from nozzles at the tips of the blades, about like the ancient æolipyle or a rotating garden sprinkler. They claim that according to their tests the fault of other helicopters lies not in the great power needed, but in bad mechanical construction and multiple parts. What is unusual is that the propeller has but two blades, being imitated from the natural screw seen in the sycamore seed flyer. In the center of gyration is placed the car, and its angle with reference to the propeller can be varied by the pilot. Should the compressed air fail, the gyropter automatically takes a gliding position and falls very slowly. Forward movement in the air when flying is obtained by slightly inclining the axis so that the propeller drives the machine and also sustains it. A revolving-cylinder gasoline motor drives the air compressor which is in the shape of a blower mounted direct against the motor.

AIR FEED HAMMER DRILLS AND A LONG RAISE

BY P. B. MC DONALD.*

Considerable interest is manifested by Michigan iron men in the No. 2 shaft of the Rolling Mill mine at Negaunee. The shaft was started from the 620-ft. level last autumn and was raised to surface in five months by nine miners, three working on each 8-hour shift; they did their own timbering and trammed all the rock 750 ft. to shaft No. 1. The difficulties of raising so great a distance were successfully overcome, and no accidents or long delays were encountered.

ENLARGING RAISE FROM SURFACE DOWNWARD.

The raise driven to surface was 8x8 ft., and this is now being enlarged to 12x14 ft., by working down from the surface, permanent timbering being put in at the same time. In this work of enlarging, the same rock drills which were used in raising are employed; this application of stoping, air-feed, hammer drills to the work usually done by heavy reciprocating drills, is uncommon

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Mining Engineer, 102 West Main Street, Negaunee, Mich.

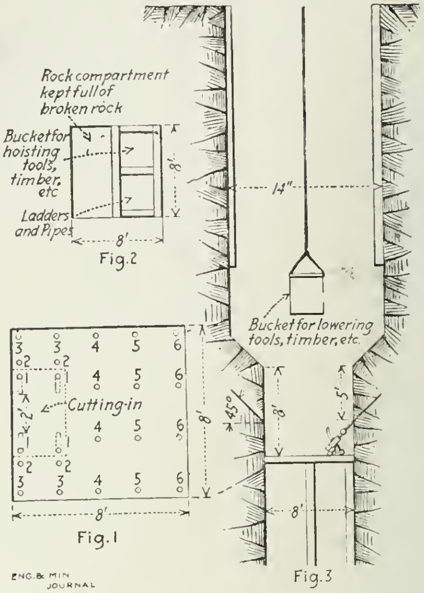
and is accomplished by using 45° holes from below, to lift a 5-ft. cut, with the length of holes so gaged as to make the shaft of the required dimensions. On May 1, enlarging had been in progress for about two months, and the finished shaft was down 260 ft.; it was planned to take five months for raising and five months for finishing the shaft, and this schedule will probably be beaten. The work is under the direction of Capt. E. N. Cory, who has charge of underground operations at the mine for the Jones & Laughlin Company.

ARRANGEMENT OF HOLES.

Fig. 1 shows the arrangement of holes for blasting, in driving the 8x8-ft. raise. The four holes numbered 1 are the cutting-in holes and the lengths of fuse were cut so that these would go first, and as nearly together as possible; the distance between the bottoms of the cutting-in holes was generally about 2 ft. The four holes, numbered 2, would go next, and these were given a small angle toward the cutting-in holes in order that their bottoms would not have too much to break. Holes No. 3 went next, and these completed a clean opening across the raise. In succession holes 4, 5 and 6 were fired, breaking easily into the opening made by the cutting-in holes and holes Nos. 2 and 3. All the fuses were lighted at once, the succession of explosions being regulated by comparative lengths of fuse, as it was not convenient for the men to fire the cutting-in holes and then to return to insure that these had broken before firing the others, as is sometimes done in drifting. The rock for the most part was jasper, with occasional streaks of schist, dipping at rather a steep angle to the vertical; the ground, however, usually broke evenly, and little allowance was necessary for the dip. The arrangement of holes in the sketch shows 24 holes, for the usual cut; sometimes in hard ground more holes were needed to help the cutting-in holes, while in soft ground it was possible to break the cut, using three holes each in sets Nos. 4, 5 and 6, instead of four holes.

DRIVING THE RAISE.

Sketch No. 2 shows the method of cribbing the 8x8-ft. raise, which was done by the miners. One 4x4-ft. compartment was used for a bucket for hoisting tools, timbers, etc., for which purpose there was a small hoist at the bottom of the raise in a station cut for that purpose. The other 4x4-ft. compartment was used for ladders and pipes. The ventilating current came up one 4x4-ft. compartment and went down the other, the fan for this purpose being stationed at the foot of shaft no. 1, 750 ft. away; the reason for placing it so far away was to insure getting pure air. The 4x8-ft. compartment was used for broken rock and was kept full, thus holding the cribbing firm. After blasting a cut, the miners trammed about 30 cars of rock from the rock compartment, drawing it off through a chute on the 620-ft. level. This took about three hours, by which time the powder smoke would be gone and the men could go up to the face for timbering.



Raise at Rolling Mill Mine, Michigan

Just before blasting, a platform of 10-in. timber, squared on two sides, was laid across the two 4x4-ft. compartments, at an angle to deflect the falling rock into the rock compartment. A small opening was left in the 10-in. platform to permit the man who lit the fuses to escape through the raise. About four-fifths of the broken rock from the explosion fell into the rock compartment, because the cutting-in was paced over the rock compartment and the material shot directly downward, and the ground broken by holes

Nos. 4, 5 and 6 was thrown sidewise toward the cutting-in.

The surface soil was but a few feet thick over the shaft site; this was cleared away, but practically no sinking was done to meet the raise. When about 15 ft. below the rock surface, a smaller size raise was driven up a short distance, and drill holes put up and loaded heavily with powder, which, when fired, broke the raise through.

ENLARGING THE SHAFT.

Fig. 3 shows the unique method of enlarging the shaft, by which the same stoping air-feed hammer drills that were employed for raising, were utilized. These drills are butterfly valve, 2-in. cylinder, Ingersoll-Rand, B C 21 machines. The holes are put in at an angle of 45°, which is enough slope to allow the rock chippings to fall out. The length of the holes is so gaged as to make the enlarged shaft of the proper dimensions, and the rock usually breaks satisfactorily; only occasionally is it necessary to put in a pop shot, after a blast, to even up the walls. In such a case, the ordinary practice of placing holes is to use down holes, drilled vertically, perhaps 3 ft. apart. These holes could be drilled by reciprocating machines, mounted on tripods or long bars, or could be drilled by small plug drills, with hollow steel for blowing or washing out the rock cuttings. The objection to using reciprocating machines and tripods or bars is that they are heavy to handle in getting out of the way for blasting; also down holes often cause trouble in getting the rock chippings out. The last argument applies to the use of plug drills as well. It is probably faster drilling, per foot, with air-feed hammer drills at a 45° angle, with the rock chippings falling back out of the way, than to drill down holes with their liability to give trouble from drill steel getting stuck.

The footage to be drilled, using 45° holes to enlarge an 8x8-ft. opening to 12x14 ft., is probably less than with vertical holes. The platform made by putting timbers across the top of the cribbings gives a convenient place for the men to stand. Furthermore, the air-feed hammer drills were at hand, ready to use, and the same nine men that drove the raise are now enlarging the shaft with the same drills. The broken rock is trammed to shaft No. 1 by trammers. There is a little trouble in the shaft at present, due to an unusual flow of water, much of which comes from the spring break-up on surface. Carbide lamps are found to be more reliable than candles. Washington fir is used for the permanent timbering.—*Engineering and Mining Journal.*

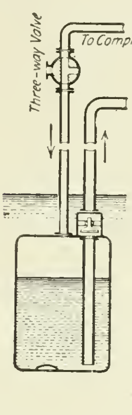


FIG. 1

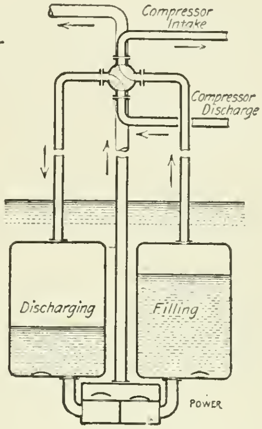


FIG. 2

COMPRESSED AIR FOR RAISING WATER—II

BY FRANK RICHARDS.

Naturally, the first arrangement thought of when it is proposed to use compressed air for raising water is that in which the water is displaced volume for volume by the air, this air being compressed to a pressure corresponding to the height of the lift, and this scheme has been worked up in a great variety of ways but with little variation of result.

DIRECT DISPLACEMENT PUMPS.

Fig. 1 shows diagrammatically a pumping apparatus of this type. The submerged chamber here shown is assumed to have been filled with water and this water is now being expelled by air pressure. The air comes direct from the compressor, passes the three-way valve and enters the top of the chamber, its pressure driving the water up the vertical pipe at the right. When the water is all expelled, the three-way valve is changed to the other position, shutting off the compressed air and opening communication between the interior of the chamber and the atmosphere and allowing the air to escape. Then the valve in the water pipe at the upper right-hand corner of the submerged chamber closes by its own weight and the pressure of the water above it, and the water rushes into the chamber through the valve at the bottom. A reversal of the three-way valve to the position shown puts the compressed air at work again and the content of the chamber is expelled as before, and so on. The three-way valve is usually operated by a float, making the operation automatic. There are generally two of these displacement chambers, which work in connection, the same valve-operating mechanism serving for both, and thus as one is filling while the other is discharging, the water flow is almost continuous.

It is well understood that the displacement pump does not use the air to good advantage, but for economy it is still much better than the air-driven, direct-acting pump. There is no friction of reciprocating parts and the clearance losses are very small, so that instead of the 20 and 20 per cent., which is allowed for the direct-acting pump, a single 10 per cent. will fully cover these items, leaving at this stage 90 per cent. instead of 64. The loss for the same pressures in not using the air expansively would, of course, be unchanged, and therefore the 34 per cent. which was assumed would still apply, and 34 per cent. of 90 being 30 there is 60 per cent. efficiency for the displacement pump instead of the 43 per cent. of the air-driven, direct-acting pump, and 57 per cent. instead of 41 per cent. when the air leaves the compressor.

The economy of the displacement pump is much better where the lift is small, which makes it specially applicable for transferring sewage and similar service, especially as the water may be loaded with a large proportion of solids and semi-solids without impairing its action.

RETURN-AIR PUMPING.

The progress of invention in any line seems to be one of gradual but continuous revelation and development. Every device, so that it will work at all, seems to have a right to be completely tried out, and to have all its possibilities and its defects revealed before it can expect to be and actually is displaced by something better.

When the power-wasting and otherwise objectionable direct air-pressure, water-raising apparatus has had its every chance and has been found wanting, then, and not until then, comes another device which is at once hailed as just what is needed. The principle of it is at once self-evident, and its perfect success when applied requires no practical demonstration.

This is the return-air system of compressed-air pumping. Its operation, in contrast to that of the direct-displacement pump, is that while the old pump will take all the air that is given to it for raising and delivering a given weight of water, and will return absolutely nothing of what it receives, this new device will take only the pressure and volume of air which exactly pays for the work done, and, so to speak, it returns all the change.

The whole thing can be simply explained, the diagrammatic sketch in Fig. 2 perhaps assisting. It must be premised that a return-air system is not a cheap and handy little device ready to go, for instance, wherever a steam pump might be employed, and to do the same work; it is intended for large and permanent installations, each plant being complete in itself and doing no other work.

THE APPARATUS USED.

There is, first of all, an air compressor whose entire business it is to operate the one pump, the capacities of the pump and compressor being adapted to each other. There is nothing special about the compressor except that it is a single-stage, reciprocating machine, and it, of course, may be driven by any available style of power transmission and application.

The pumping part of the apparatus consists of two similar chambers to be alternately filled with water and emptied by the expulsion of the water to the level required. These chambers are submerged in the water to be pumped, or at least are located near and below the lowest working level of it, so that the water will always be able to flow into either chamber by gravity. The compressed air is conveyed to the pump from the compressor by separate pipes to each water chamber, and each pipe also leads the air, after its work of water expulsion is done, back to the air intake of the compressor. It is thus a closed system, and the same air is used over and over again, provision being made for continually replacing the little that may be lost by leakage or by absorption in the water. The valve arrangements are clearly shown in Fig. 2.

OPERATION.

Assume that the pump is actually at work, that one of the chambers is full of water, with sufficient air pressure flowing in at the top of the chamber, exerting its pressure upon the water and driving it through a retaining valve and up a water pipe to the point of delivery.

Thus far the operation is precisely the same as with any displacement pump, and when the water is all, or nearly all, driven out the chamber is full of air at the pressure required and determined by the height of the water delivery. The regular operation by the old way would now be to close the communication with the compressor and to open another to the atmosphere, allowing the air, expanding as it goes, to escape without doing any more work and leaving the chamber filled with air at normal atmospheric pressure. Water is then allowed to flow in and to fill the chamber again, which drives out the remainder of the former charge of air, and this chamberful of water is driven out and up by another charge of full-pressure air as before, and so on.

With the return-air system, however, the air is not let off so easily, but is retained to do a lot more work. The air is discharged from the water chamber and up the air pipe which, by the action of an automatic or a positively operated switch, is now in connection with the intake instead of the discharge of the compressor, and whatever pressure this air may have is thus always being exerted upon the intake side of the compressing piston, and the pressure upon this side overcomes an equal amount of resistance upon the compressing side of the piston, or it deducts just so much from the total power required to drive the piston and to do the work of recompression.

Using the air in this way, its entire expansive force is retained upon the credit side of the system. Expansion continues until the air pressure is lower than that of the water which is waiting to enter, the difference of these pressures depending upon the speed at which the system is being driven, and then the water enters and drives the remainder of the air into the compressor intake at this pressure instead of letting it further expand, and thus raises the total mean effective assisting pressure at the back of the piston above that which would have resulted from the expansion alone.

Each return-pipe installation is an individuality, with special conditions to be satisfied and calling for special sizes and capacities, both relative and actual. The system is advantageously applicable to both extremes of the possible range of practical requirements, and to all between.

CONSTANT LIFT SYSTEM.

Where the lift is practically constant, as in raising water from a lake or river to a water-works reservoir, the compressor and the pump may be so adapted in capacity as to ultilize all the expansive force of the air with comparatively little of the follow-up pressure from the water, but still with the highest possible ultimate efficiency and economy. In any case, as the compressor is in immediate touch with its work there is no loss from overcompression or from compressing above the actual requirement, as is often the case with the direct-displacement systems.

VARIABLE LIFT SYSTEM.

If the return-air system is employed where the level of the water intake has a considerable variation of height, as in emptying a large, deep shaft of a mine, the follow-up pressure of the water in refilling the operating chambers will vary constantly with the water level, and at all levels will approximately adjust the work of the compressor according to the actual water lift at the time; and, although the water must always be lifted under the full actual head at the time, and with the requisite over-balancing pressure for the expelling air, the compressing of the air to that pressure will require little or much power according to whether the return, or intake, pressure at the compressor is much or little, corresponding to the height of the water supply. With the direct displacement, and no return of the air, there would be none of this compensation, either from the re-expansion of the air or from the follow-up pressure of the incoming water, and all the water lifted, whether the level of the supply was high or low, would require the maximum and entirely uncompensated pressure to raise it.

AN EXAMPLE OF APPLICATION.

There was a case where it was necessary to provide, and to have constantly ready the means of emptying a shaft of considerable area, more than 300 ft. deep and normally full of water, with a tunnel at the bottom of the shaft also to be emptied. This will be recognized at once as a problem easy enough of solution, in a way, but not so simple when speed and economy were to be considered. There had been actually installed for this work a hoisting engine and a large cylindrical bucket, say 4 ft. in diameter and 12 ft. long, to be successively filled, hoisted and emptied.

This might strike one as a rather primitive arrangement, but it had at least the merit of using the power with reasonable economy. The varying height did not at all affect the weight of the bucket of water, and the power consumed was therefore always directly as the height, and with engines showing good steam economy the arrangement was not wasteful of power. This bucket arrangement was actually used for emptying the shaft and tunnel once and it worked all right, but nevertheless it was superseded by the return-air system, which could show good power economy and could do the required work in much less time, which in this case was the all important consideration.

The shaft here spoken of is known as shaft 25 of the "new" Croton aqueduct, and the tunnel is the portion of the aqueduct which crosses under the Harlem River, 300 ft below its surface, near Washington Bridge, New York City.

VALVE ARRANGEMENT AND OPERATION.

In the foregoing outline of the operation of the return-air system reference has been made only to the action in one submerged operating chamber. It is understood that there are two similar chambers operated alternately, one filling while the other is emptying, so that the lifting is practically constant. The four-way valve or switch, as it is called, for reversing the connections of the two pipes at the proper times is operated in different ways according to the work. For a straight, steady waterworks job the switch may be operated mechanically, tripping one way or the other for each given number of revolutions of the compressor; it may be operated automatically by the fluctuations in the level of the water supply, and it may also always be operated by hand. It is not necessary to completely fill either chamber before reversing because the unused pressure is not lost in any case, and there is nothing corresponding to the clearance losses in the direct-pressure ejection system.

The actual installations of the return-air pumping system already show a wide and interesting range of successful employment; what the device needs most of all is to be better known. It seems to decline no job which is possible by any system, and it works for the lowest air output, and is especially successful in many lines which are not permissible to the formal mechanical devices. It pumps, for instance, water which is so charged with solid matter that it can only be called semi-liquid. It is in some cases regularly employed for conveying the solids so contained, as sand or marl, the mixture when so raised going to settling tanks where the water is allowed to flow off, leaving the solid portion to be shoveled or otherwise handled and conveyed wherever required.—*Power.*

SCIENTIFIC MANAGEMENT

A certain superintendent of one of the large eastern contracting companies, who was especially fine on running his business scientifically, found a railroad spike while walking over the work. Picking it up, he hastened to the foreman, and the following conversation took place:

Superintendent: "John, I found this spike on your section of the work. Why was it left there?"

Foreman: (Removing his hat and scratching his head) "Did you find that spike?"

Superintendent: "Yes, right there alongside of that dinky track, and I want to know why it was there."

Foreman: "Well, that certainly is funny."

Superintendent: "Funny, I don't see anything funny about it."

Foreman: "Funny, yes, very funny, I can't understand it for the life of me."

Superintendent: (About getting hot under the collar) "Look here, you. If there is anything funny about my finding this spike, I do not see it, and what is more, I want no such further remarks. Why was that spike there?"

Foreman: "I say it's funny, because my tally sheets showed that very spike to be missing, and although I had three of my best men hunting for that spike two days, they failed to find it."—Adapted from *Steam Shovel and Dredge.*

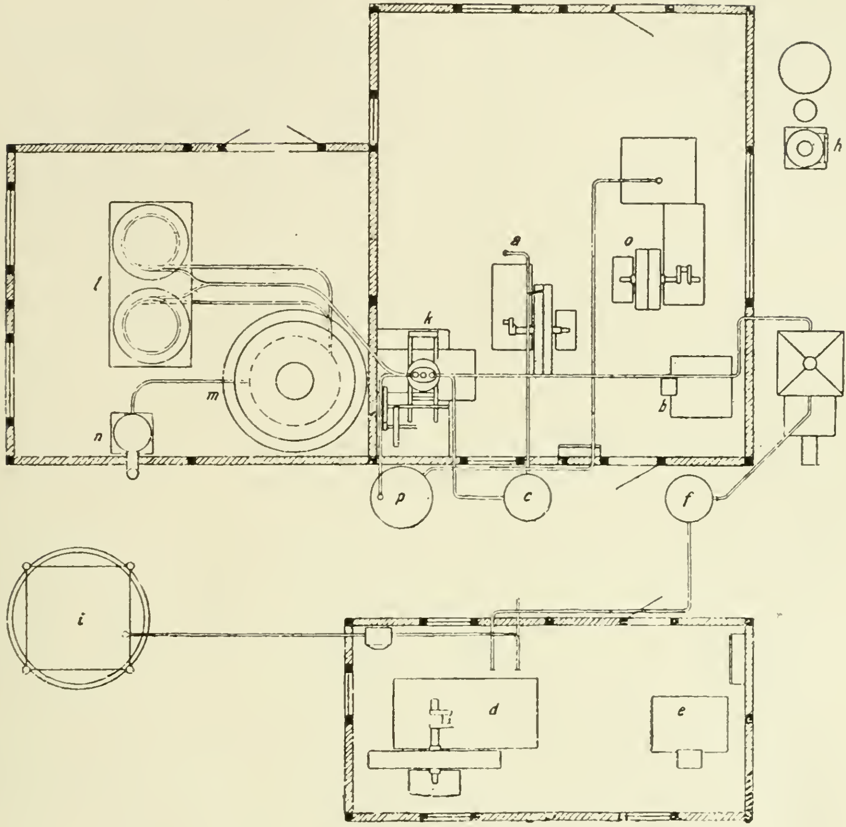


FIG. 1. COKE-OVEN-GAS NITROGEN PLANT.

ATMOSPHERIC NITROGEN BY THE AID OF COKE OVEN GASES

Several methods have been proposed for recovering nitric acid from atmospheric nitrogen, in addition to the electric process worked in Norway by water power. That of Häusser produces nitric oxide by the explosive combustion of coke-oven gas. After numerous experiments on a laboratory scale, an apparatus for practical use has been constructed at Nuremberg by the Dentsche Stickstoffindustrie G.m.b.H., on the lines shown in plan in Fig. 1. Here, *a* is a compressor with 10-in. cylinder and 12-in. stroke, driven by a motor, *b*, compressing town gas to 60 lbs. per sq. in., and delivering it into a pressure chamber, *c*. The air of combustion is furnished by a two-stage compressor, *d*, with 18-in. stroke, driven by the motor, *e*, and capable of compressing 31,800 cubic ft. of air to 90 lbs. per sq. in. The fluctuations in pressure are compensated by means of an accumulator, *f*. To increase the yield of nitrogen, the air of combustion is heated by a furnace, *g*, fired with gas from a small producer, *h*, and oxygen is mixed with the air from a gas-holder, *i*. The bomb, *k*, in which the explosion is produced has a capacity of 3½ cubic feet., and, as shown in Fig. 2, consists of a cast-steel cylinder with hemispherical ends and provided with a water-cooled jacket. The valves are operated by the motor, *b*.

The products of combustion are passed through a coil in the cooling tank, *l*, where the contained moisture is deposited, the cooled gases then passing to the oxidising tower, *m*, and finally escaping through the terminal tower, *n*, into the air. It is found advisable to scavenge the bomb with air, forced in at a low pressure by a compressor, *o*, through an accumulator, *p*. In working without any preliminary heating of the air of combustion, or any addition of oxygen, the initial pressure of 27 lbs. per sq. in. increases in one-tenth of a second (at the moment of explosion—which is effected by means of a Bosch magneto) to about 210 lbs. per sq. in., and remains thereat for about one-sixth of a second, during which period the chief production of nitric oxide takes place. The expansion lasts a quarter of a second, so that about half a second is required for explosion and exhausting. The temperature corresponding to this explosion pressure is about 1,350 deg. C. The gas used contains 44 per cent. of hydrogen, 26 per cent. of methane, 14 per cent. of carbon monoxide, 4 per cent. of other hydrocarbons, 3 per cent. of carbon dioxide, 1 per cent. of nitrogen, and 8 per cent. of exygen, and therefore approximates coke-oven gas in composition. Its minimum calorific power is 4,330 cal. per cubic metre of gas at zero C., and 30-in. pressure.

With low initial pressure (14¼ lbs. per square in.) the average yield of nitric acid is 4 grammes per cubic metre (35.3 cubic ft.) of exhaust gas, or 35 grammes per cubic metre of original gas. Doubling the initial pressure, however, raises these quantities to 6—7 and 55 grammes respectively, whilst trebling the pressure gives 9—10 grammes and 80 grammes respectively of nitric acid, owing to the more intimate juxtaposition of the molecules of gas and air, and to the higher combustion temperature (1,450—1,550 deg. C.). There is every reason to suppose that a further increase in pressure would give a still higher yield of oxides of nitrogen. Another way of accomplishing the same object consists in heating up the air of combustion beforehand, experiments with air heated to 250—300 deg. C., and intial pressures of 28—56 lbs. per square in. having given combustion temperatures of 1,600—1,700 deg. C., and a yield of 80—125 grammes of nitric acid per cubic metre of gas. Under these conditions the explosion pressure increases more rapidly, is maintained longer, and then sinks more quickly than when cold air is used, which phenomena favour the production of oxides of nitrogen and retard their decomposition. The air could be still further heated without expense, when working on a large scale, by means of the effluent gases, which have a mean temperature of about 1,000 deg. C.; and the resulting cooling of these gases would bring with it the additional advantage of lessening the tendency to decomposition on the part of the nitrogen compounds.

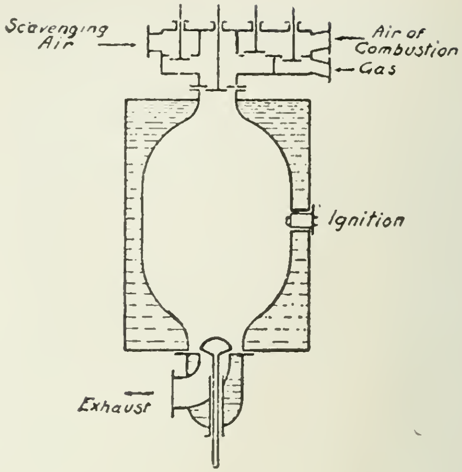


FIG. 2.

A third means of increasing the yield of nitric acid is by the addition of oxygen to the air of combustion. The oxygen (98 per cent. pure) is transferred from the cylinders into a gas-holder, and passed thence through a meter to the intake of the compressor. With an initial pressure of 43 lbs. per square in. of cold air and 33—34 per cent. of added oxygen, the yield of nitric acid obtained was 130 grammes per cubic metre of gas, or an increase of 60 per cent. in comparison with the corresponding results without added oxygen. Absolute purity not being essential for the oxygen, it could be produced by the Claude process at less than $0.025 per 100 cubic ft. Assuming the nitric acid to be concentrated to 94 per cent., at a cost of $0.625 per cwt., the increased yield obtained by adding oxygen will be worth about double the cost of the oxygen employed, and will exceed the latter by about 50 per cent. if the product is worked up into the less valuabe calcuim nitrate; so that, provided the oxygen can be produced on the premises in large quantity, its application is profitable in all circumstances.

In all the experiments it was found that, once the plant had been set to work with definite quantities of gas, air, and oxygen, and at a definite number of explosions per unit of time, the explosion pressure remained approximately uniform in all cases, the yield of nitric acid being consequently also regular. From the results already obtained, it seems justifiable to assume that, with an initial pressure of 72 lbs., the addition of 33 per cent. of oxygen, and with air heated to 250—300 deg. C., the yield of nitric acid per cubic metre of gas can be raised to more than 200 grammes (about 1¼ lb. per 100 cubic ft. of gas).

With regard to the recovery of nitric acid from the nitric oxide obtained, this has not yet been carried out at the experimental plant, but, judging from the practice at the electrical nitric acid works at Notodden, where gases containing 1 per cent. of nitric oxide are successfully treated, there does not appear to be any difficulty about this stage of the process, since, under the last-named conditions of generating the oxide, the gas will contain the above percentage. At the works in question, the gas is passed through scrubbing towers, where the nitric oxide combines with water to form nitric acid; and as the weak acid liquor from one tower is passed through the others in succession, the acid is concentrated to a strength of 33—34 per cent. For making calcium nitrate, this acid is neutralized with limestone, whilst for making commercial acid it is concentrated and distilled.

The commercial possibilities of the Häusser process, when applied to the surplus gas (about 50,000 cubic metres in 24 hours) of a battery of 40 modern coke ovens, are indicated by the following estimates. The experience already acquired demonstrates that, in this process, gas with a calorific value of about 4,300 units, requires about five times its own volume of air and 33 per cent. of added oxygen (both compressed to about 75 lbs. per sq. in. pressure in separate compressors), in order to obtain a minimum yield of 200 grammes of nitric acid per cubic metre of gas. The bomb has to be scavenged out with a quantity of air corresponding to one-fifth the volume of air required for combustion, so that the compressor plant would have to deal with 314,000 cubic metres of air, 50,000 cubic metres of gas, and 16,000 cubic metres of oxygen (compressed to 75 lbs. per sq. in.) in 24 hours. This task could be performed by three sets of compressors (two for continuous use and one in reserve), namely, three air compressors with a capacity of 7,000 cubic metres per hour; three gas compressors, capacity 1,000 cubic metres per hour; and three oxygen compressors, capacity 350 cubic metres per hour (all measured at the intake). The coke-oven gas should preferably be stored in a gas-holder to equalize the pressure, the same result being obtained for the air and oxygen by means of wind chests. The capacity of the bombs may be about 300 litres (10.5 cub. ft.), and the number of ignitions 50 per minute; so that for the plant under consideration, with air heated to 300 deg. C., six bombs would be required. The preliminary heating of the air can be effected by passing it through coiled pipes mounted in the flues of one or more boilers, which flues will be connected with the exhaust of the bombs. The low-pressure steam thus raised in the boilers can be utilized for heating purposes.

The condensing plant will comprise two oxidation towers, six absorption towers, two nitrate towers, pumps, acid store, concentrating appliances, dissolving and crystallizing tanks and a crushing mill. The cost of land and buildings may be set down at $25,000, that of the compressing and generating plant (including boilers, pipes, travelling crane, etc.) at $137,500, and the condensing and concentrating plant at $100,000, the oxygen plant costing about this latter sum, so that the total capital outlay required would amount to $362,500. Assuming a consumption of about 1 lb. of steam for compressing 100 cubic ft. of air, gas, and oxygen (measured at the intake), the annual cost of steam would be $40,000; oil, cleaning material and lighting, $4,500; oxygen, $39,250; concentrating 3,500 tons of acid, $43,750; labor and salaries, excluding the oxygen plant and concentration plant, $10,000; repairs, $7,500; general expenses, taxes, etc., $15,000; depreciation of plant (10 per cent.), $26,250; a total of $186,250.

Allowing 5 per cent. for loss of acid in the condensing plant, the net yield would be 190 grammes per cubic metre of gas, or 3,320 tons of nitric acid per annum, which, at $100 per ton, would furnish an income of $332,500 gross, the net surplus, after deducting all expenses, being $146,250, equivalent to about $0.025 per 100 ft. of gas treated. With coal at $2.50 per ton and of a heating value of 7,500 cal., the gas would cost rather less than $0.005 per 100 cubic ft., and in comparison with its value for steam raising, the production of nitric acid would show a profit of about $113,750, or 31 per cent. on the capital expenditure. There would, however, be some difficulty in disposing of such a large production of nitric acid, as such, without affecting the price, and therefore the bulk of the output would have to be worked up into fertilizing salts, such as nitrate of lime, for which there is always a good demand. The recovery of this salt is less expensive than that of concentrated acid, the cost of concentration ($43,750) being saved, whilst the general expenses would also be about $10,000 less. Limestone, with about 98 per cent. of $CaCO_3$, can be bought for about $0.95 per ton, the 2,700 tons necessary for treating the whole 3,320 tons of nitric acid thus costing about $2,500. The total cost of production would be approximately $135,000, instead of $186,250 in the case of concentrated acid. Valuing the nitrogen on the same basis as that in sulphate of ammonia, the nitrate of lime would be worth a price equivalent to $72.50 per ton of nitric acid, and this would mean a total selling value of $240,000; that is to say, a profit of $105,000 per annum. In comparison with the value of the coke-oven gas for steam raising, this return would be equal to an advantage of about 20 per cent. on the capital outlay. By combining the production of concentrated nitric acid and of nitrate of lime, an average net profit of 25 per cent. could be obtained.

While the profits at first sight do not seem to be large in comparison with those of the sale of coke-oven gas for lighting purposes, it should be remembered that the gas has to be enriched for this latter use, the benzol cannot be recovered, and the cokery has to be managed with particular care, heavy outlay being also required for gas-holders, mains, etc., whereas all the surplus cokery gases can be utilised in the Häusser process, after being deprived of their valuable by-products. For the coal industry the process offers the advantage of converting the surplus gases into a valuable end product on the spot, and there is no intereference with the sale of coal to gasworks. Similar considerations apply where coke-oven gas is utilised for generating electrical energy for sale, and the plant has to be partially closed down at certain hours when the demand for electricity is relatively small. Even, however, if the economic superiority of the process were far smaller than it is, it would still be valuable for utilising the enormous quantities of surplus gas now available. How great these quantities are may be gathered from Lürmann's estimate that, in the Dortmund district alone, they amount to 63,570 million cubic ft. yearly.

The employment of coke-oven gas, moreover, does not exhaust the possibilities of the process, which may also probably be applied to the utilisation of tar oils, now that these can be gasified. Another suitable raw material for the process is to be found in very ashy gas and bituminous coals, which do not pay to wash owing to the amount of loss, and are therefore left unworked. Such coals might be retorted, either alone or mixed with gassy waste from the classifying plant, the gas being employed for nitric acid making. The producers for carrying on the operation could be of a duplex type, the gasification and coking being effected in the upper portion, thus forming rich gas, which could be treated separately for the recovery of by-products and then, in some cases, mixed with the producer gas from the lower portion of the apparatus, the mixture being used for the Häusser process. The bulk of the producer gas, of low calorific power, but also low in tar, could be purified and employed in gas engines furnishing the motive power for the nitrogen and oxygen plants. Whether this is a commercial proposition, however, could not be decided without actual trial; but if it should turn out a success, it would enable a number of now unworkable coal seams to be worked, and thus eke out the national coal supplies considerably.

The amount of motive power required for the process is comparatively small, and therefore the capital outlay needed is less than that for generating electricity from water power. The process can be carried out in industrial centres, and therefore close to the market for the final products, whereas the nitric acid produced by means of water power and electrity has to be transported for long distances to reach the centres of consumption. Finally, the process would bring the manufacture of the chief nitrogenous fertilizers entirely into the hands of the coal industry, viz., sulphate of ammonia for autumn use and nitrate of lime for spring top-dressing.

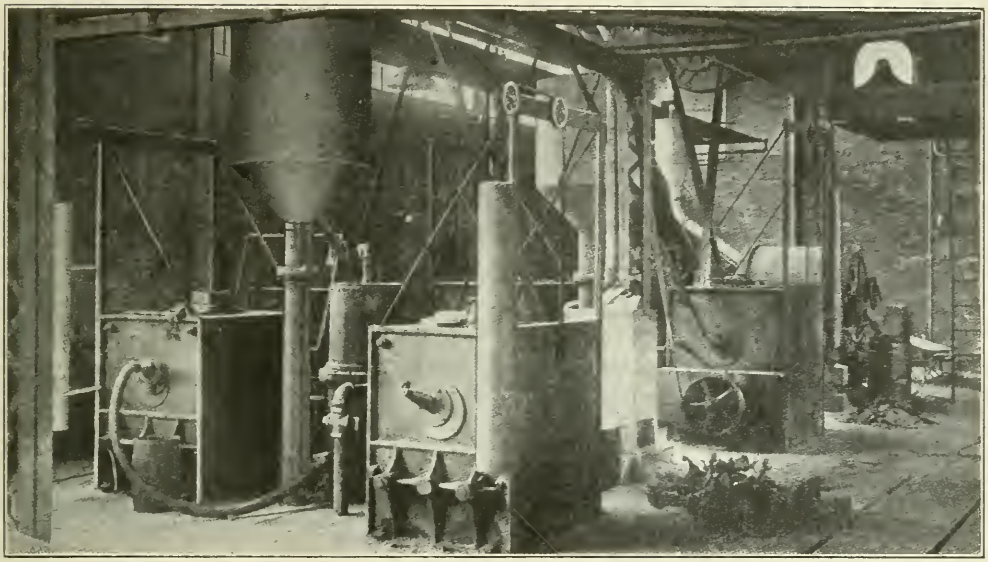


FIG. 1.

THE SAND BLAST IN A MODERN FOUNDRY

The *Foundry* for July has an elaborate description of the new foundry of the Taylor & Boggis Foundry Company, Cleveland, Ohio. This is an extensive plant devoted to the manufacture of gray iron castings and builders' hardware, embodying the latest ideas and employing the latest facilities in all departments, and quite naturally compressed air is an important and responsible feature. The electric drive is employed in the powerhouse, a 150 horsepower General Electric motor driving a twin cylinder air compressor of 1,350 cubic feet per minute free air capacity at 35 lb. pressure, all this air being used for the sand blast equipment. Then there is a two-stage high pressure compressor with a capacity of 450 cubic feet of free air per minute compressed to 100 lb. for the molding machines, the chipping hammers and the air hoists.

We can speak here only of the sand blast equipment, which is unusually complete. It comprises five sand blast tumbling barrels and a sand blast room for cleaning large castings. Provision has been made for the installation of a second room of this type. The sand blast barrels are shown in Fig. 1. The barrels are belt driven by a motor on a platform at one end of the department. The separators, blowers and exhaust fans, seen in Fig. 2, are on a mezzanine floor, the fans being driven by individual motors. The steel plate sand blast room is illustrated in Figs. 3 and 4. An extension of the industrial track passes through the center of the room which has double doors at each end.

Castings are delivered to this room on flat cars, and after being sand blasted they are conveyed to the cleaning room, Fig. 5, for subsequent chipping operations. The floor is perforated and the sand falls into a hopper from which it is exhausted, and after being cleaned and separated it is again delivered to the sand blast room for further use. The lighting of this room is unique. Being en-

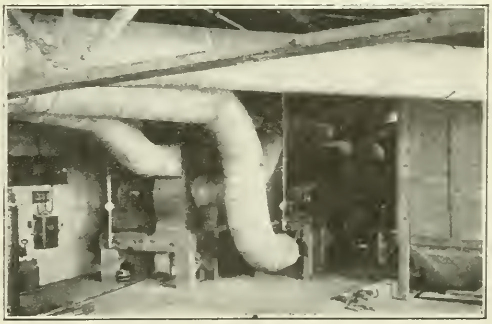


FIG. 2.

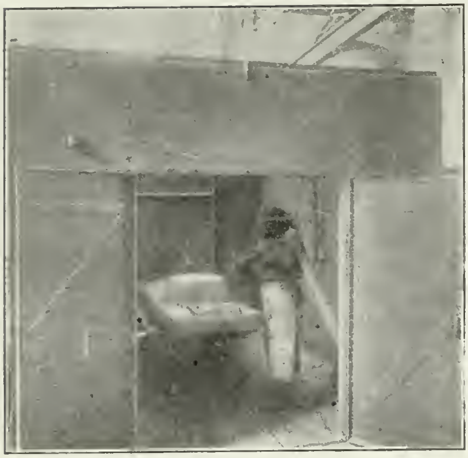


FIG. 3.

tirely enclosed on all sides by steel plates, light is admitted through the roof, which is of glass. Four electric arc lamps are suspended above the roof so as to project their rays directly into the sand blast room. Four of the sand blast tumbling barrels, as well as the steel sand blast room, were installed by the Tilghman-Brooksbank Sand Blast Company, Philadelphia, and one sand blast barrel was furnished by the New Haven Sand Blast Company.

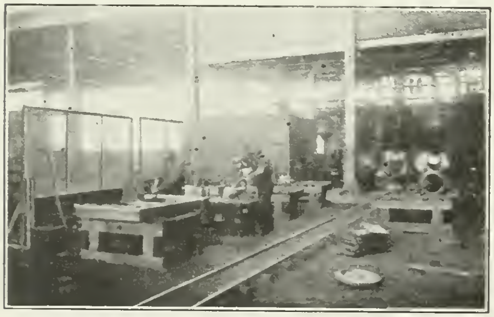


FIG. 5.

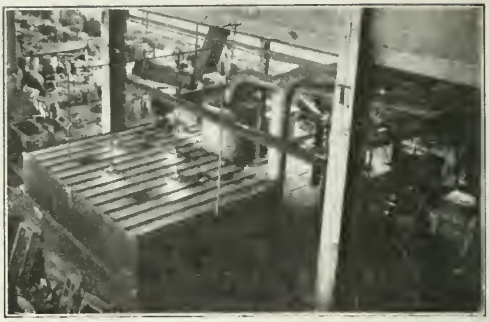


FIG. 4.

REGULATION OF POWER DRIVEN AIR COMPRESSORS

BY LUCIUS I WIGHTMAN.

Since the power driven air compressor is almost always a constant speed machine, the methods employed in regulating and governing direct steam driven machines evidently cannot be employed. Constant speed means constant displacement, and the problem of delivering a variable volume of air with constant piston displacement becomes one of making a portion of that displacement noneffective in the compression and delivery of air. Only the fundamental principles of several methods of accomplishing this will here be discussed.

The first method is really one of unloading rather than of regulating. A pressure controlled mechanism is arranged so that when pressure exceeds normal, due to excess of delivered volume over demand, a communication is opened between the two sides of the compressing piston. Usually this is accomplished by opening and holding open one or several of the discharge valves at both ends of the cylinder, the air then simply sweeping back and forth from one side of the piston to the other through the open valves and the air discharge passage. When normal pressure is restored, the valves are automatically closed, and compression and delivery are resumed. Evidently this is practically a total unloading of the machine for a longer or shorter period —a sudden release from load and a sudden resumption of load.

Another method provides, by means of a pressure operated device, for the partial or total closing of the compressor intake under reduced load. To avoid the dangers attendant upon such an operation acting suddenly, these devices are provided with some damping mechanism so that they are compelled to operate slowly, making the release or resumption of the load gradual. Cutting down of the air intake results in a rarification of the air entering the cylinder, and a greater range between initial and discharge pressures, with a corresponding increase in the range of temperatures. This method of regulation, therefore, is not suitable for very great load variations; nor is it recommended for such conditions by the builders responsible for it.

The third method is very similar to the first, except that here the inlet valves, instead of the discharge valves, are held open when the machine is unloaded, the piston thus simply drawing in and forcing out air at atmospheric pressure. It is open to the same criticism (though in somewhat less degree) as the first method, namely, undue shock and strain on release and resumption of load.

The fourth method uses a pressure-controlled valve on the compressor discharge of a single stage machine, combining also the functions of a check valve to limit the escape of air from the receiver or air line. Excessive pressure blows the discharge to atmosphere, instead of into the line. This arrangement is also used on two-stage machines by placing it on the low-pressure discharge to the intercooler. Then, when the governor valve is opened by excess pressure, the low-pressure cylinder discharges to atmosphere, and the high-pressure cylinder acts simply as a low-pressure cylinder with intake at atmospheric pressure. This device is more of a relief valve than an unloader, for the piston must continue to compress to a pressure which will open the discharge valve; and this volume of compressed air, with its power equivalent, is wasted.

Yet another method of regulation provides auxiliary clearance spaces, or pockets, at each end of the cylinder, which are successively "cut in" as load diminishes. The excess air is simply compressed into these clearance spaces and expanded on the back stroke. The capacity of the cylinder is reduced without any appreciable waste of power, for the energy used in compressing the clearance air is given back by its expansion.

On power-driven compressors with Corliss intake valves, several different methods of unloading or regulating are used. By one method, the Corliss valve is held open for the full admission stroke, and also for a part of the compression stroke, this latter portion being determined by the degree of unloading called for. Evidently this is practically equivalent to a shortening of the stroke of the compressor.

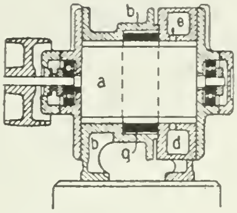
By another method the Corliss intake valve is opened full at beginning of admission, but closes later in the admission stroke. The air admitted to that point is expanded or rarified for the remainder of the compression stroke, and then compressed, the volume of compressed air delivered being of course reduced. This arrangement is productive of an excessive temperature range in the cylinder. Still a third method opens and holds open the intake valves at the end of the cylinder, or at opposite ends in duplex machines. The effect of this is to make ineffective one out of every two strokes. If still further unloading is necessary, the intake valves at the other end of the cylinder or cylinders are opened and held open.

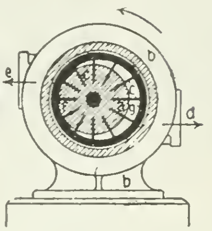
The three arrangements just outlined all operate by a pressure-controlled mechanism which actuates some form of trip or release on the Corliss air valve gear, somewhat similar to the release mechanism of the Corliss steam valve for varying the cutoff.

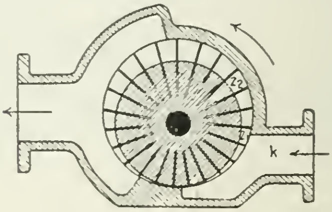
Three things are to be avoided in the successful unloader or regulator for power-driven machines; first, a sudden release or resumption of load, throwing heavy strains on the machine; second, undue rarification of the intake air, resulting in a wide range of cylinder pressures and temperatures; third, the blowing off of compressed air to the atmosphere with a waste of power.

It is usually desirable to start a power-driven compressor with no load, throwing on the load gradually after normal speed has been reached. This is in fact essential in machines driven by electric motors, for the heavy inrush of current in starting under load is dangerous, particularly where power is taken from a transmission circuit supplying other motors.

Evidently almost any of the unloading devices noted in the previous section can be used for this purpose if properly arranged for manipulation. The usual form, however, is simply a bypass valve to atmosphere on the line close to the compressor, protected by a check-valve between it and the receiver to prevent the return of air from the line when the starting unloader valve is open. This check valve is essential where several compressors serve one line, permitting cutting in or out any machine without unloading the others. This bypass valve is opened on starting when the compressor simply compresses to a pressure sufficient to open its discharge valves, the air escaping to atmosphere. When normal speed is reached the bypass or unloading valve is gradually closed and load resumed. On 2 stage-machines, an unloader valve should be provided on the low-pressure discharge to the intercooler, as well as on the high-pressure discharge to the line. In the latter case, both cylinders operate momentarily as low-pressure cylinders.







THE WITTIG ROTARY ENGINE, PUMP OR COMPRESSOR

The editor of the Journal of the American Society of Mechanical Engineers is doing an excellent service to the membership of the Society and to the engineering profession in the maintenance of the department of "Foreign Review." From the July issue of the Journal we take the following description of the Wittig rotary engine, translated and abstracted from *Dinglers polytechnisches Journal,* May 4, 1912:

These engines may act either as air or water pumps, or as steam or compressed air engines. The cut shows the schematic construction of the engine and its mode of operation. At *a*, is an eccentrically placed rotary drum provided with slots in which are placed thin vanes *c*, free to move in and out of the slots, and kept in the position shown by centrifugal force; *k* shows the steam inlet pipe, or air outlet pipe, if the engine is working as a blower. There are several small openings in the casing wall on the left, not shown in the drawing. When the engine is working as a blower or exhauster, the cells formed by the vanes *c* pass these openings as the size of the cells increases owing to the eccentricity of the drum, and expel the air: from the top of the engine, where the cells reach their maximum, they travel for some time without meeting any openings, and tend to compress the air inside them which they discharge through *k* when they reach it.

If the machine works as a motor, either steam or compressed air, the driving fluid, which will be called steam hereafter, enters from *k* into the cells opening into it, say into z_1. At the start rotation is produced by the pressure of the steam against the whole area of the foremost blade of cell z_1. As regards the enclosed cells, z_2, the author explains that there is a difference of pressure on the vanes, because the vane foremost in the direction of rotation projects further, and therefore presents a larger area to the steam pressure than the vane further back: the difference in pressures will therefore tend to drive the whole piece in the direction of rotation. The total force driving the engine is proportional to the sum of the differential pressures in the cells to the right of the figure, the exhaust openings being on the left, where the cells begin to grow smaller.

The use of a large number of vanes and cells, and the arrangement by which these cells can grow larger and smaller, is said to present the following advantages: (*a*) There are no valves necessary, the admission and exhaust being effected through uncovered openings, and compression and expansion regulated by the cells changing their size automatically. (*b*) The difference in size between two contiguous cells being slight, the difference in pressure is also small, and therefore the vanes are subjected to comparatively small stresses, and leaks from one cell to another are small as well. (*c*) At *f*, where the drum comes nearest to the casing, and where in an air compressor there would be especial need of packing to divide the suction space from compression, in this machine there is no need of packing at all, because there is always at least one vane *c* to separate the two chambers (*d*). Since the cells are filled or emptied in rapid succession, there is a practically uniform flow of steam or air both into or out of the engine, as well as a uniform turning moment on the shaft.

If, however, the vanes were allowed to press against the casing, there would be a considerable friction between them. To pre-

Number of Test	1	2	3	4	5	6
R.p.m.	900	900	900	900	900	900
Delivery pressure above atmospheric in atmospheres	4.5	4	3.5	3	2.5	2
Temperature of air at delivery, deg. cent./deg. fahr.	132 269	121 249	112 233	106 222	98 208	92 197
Volume sucked per hr., cbm./cu. ft.	202 7070	215 7525	224 7840	239 8365	256 8960	270 9450
Cooling water per sec., kg./lb.	0.21 0.44	0.21 0.44	0.21 0.44	0.21 0.44	0.21 0.44	0.21 0.44
Temperature of cooling water, deg. cent./deg. fahr.						
(*a*) entering	9/48.2	9	9	9	9	9
(*b*) leaving	23.5 74.3	20.5 68.9	19.5 67.1	18.5 65.3	18 64.4	17.5 63.5
Heat carried away by cooling water per sec., WE/b.t.u.	3.05 12	2.42 9.6	2.2 8.7	2.05 8.1	1.9 7.55	1.78 7.05
Power consumption, h.p.	27.5	23.3	21.7	20.9	19.8	18.9
Heat carried away by the air per sec., WE/b.t.u.	1.78 7.05	1.68 6.7	1.62 6.43	1.63 6.45	1.5 5.97	1.55 6.18

Barometer, 720 mm.
Room temperature, 17 deg. cent. or 62.6 deg. fahr.

TESTS OF WITTIG AIR COMPRESSOR.

vent this, there are provided collars *g* having nearly the same inside diameter as the casing, and arranged so that they have a certain play both normally to the axis and sidewise. They are carried away by the vanes with them in their rotary movement, and enclose the vanes like hoops around a barrel, the casing proper serving only as a guide to this revolving system. When in contact with the collar, each vane is drawn somewhat sidewise owing to the eccentricity of the slot with respect to the axis of the casing. This eccentricity is, however, of advantage in diminishing the friction losses. The table gives data of tests of a Wittig Air Compressor.

NOVEL SHAFT RAISING SCHEME

At the Nowata mine a shaft is being dug from the bottom up instead of from the top down, and this is the only instance of the kind in the district. The shaft was started in the roof of a drift, 220 ft. beneath the surface. Hugh Correll, superintendent, is keeping careful cost figures and reports a great saving with the shaft now at a point about 100 ft. above the drift. The method of procedure is unusual. An ordinary 8-in. drill-hole was sunk at a point where it was necessary to sink the new shaft. This hole penetrated the drift. A boiler, hoister, and derrick were placed above the drill-hole and through it a heavy wire cable was lowered, being attached at the bottom to a substantial platform, containing an air-drill. The platform is raised into the shaft as though it were a cage. A drillman prepares the rounds of holes in the top of the shaft, which, in this case, corresponds to the bottom of the average shaft. A powder-man loads the rounds; the cage is lowered to a point of safety in the drift, pulled slightly to one side to escape the shower of broken rock, and the shots are fired by electricity. All the costs of shoveling the broken rock into tubs to be hoisted and the heavy costs of pumping in a newly sunk shaft are eliminated. The saving in time also is proving a big factor in favor of this novel shaft-digging system.—*Mining and Scientific Press.*

*DUST, GASES AND HUMIDITY IN MINE AIR

Eminent mining authorities, such as Haldane, Heise and Herbst, state that the breathing of fire-damp, when it is present in such small quantities that it will not explode, is not injurious to the health of mine workers. Although a man may breathe an explosive mixture, no injurious effects will be noticed on returning to fresh air.

FUMES FROM EXPLOSIVES.

Considerable progress has been made during the last few years in bettering the quality of explosives used in mines. However, there is room for improvement, for one pound of explosive powder used in blasting coal will produce from two to four cubic feet of explosive gas. It has been determined by chemical tests that if a mine is ventilated, as required by the West Virginia mining law, the additional amount of explosive gas produced by the shooting will not have a noticeable effect on the whole percentage of explosive gas leaving by the main return. But, as the fumes contain the poisonous gas, carbon monoxide, and also carbon dioxide, methane, etc., it can readily be seen that a miner's health will suffer if a sufficient amount of air is not distributed to the working face.

SOLID IMPURITIES IN MINE AIR.

That air issuing from a mine contains solid matter enough to make it visible, cannot be denied, unless the dust particles in the air have been washed out by the moisture carried in a well-saturated current. Some mines are apt to be more dusty than others. However, if blowing fans are used for ventilating, and a sufficient amount of steam is injected into the intake air, the floating dust particles at any place in the mines will readily fall to the floor, due to the thorough washing of the atmosphere when the dew point is reached. Free the air of this dust by washing it, and you will thereby protect the health and enhance the efficiency of the coal digger.

VENTILATION - QUANTITY, TEMPERATURE AND MOISTURE.

From 0.5 to 1 per cent. of methane is permitted in the return air from splits and in the main returns of German mines but only where locked safety lamps and permissible explosives are used exclusively. Considering that we must employ a large percentage of foreign laborers, many of whom cannot understand the English language and who have a limited knowledge, if any, of the dangers of firedamp and blackdamp. I believe that the maximum percentage should be: Methane 0.6 per cent. and carbon dioxide 0.3 per cent. in all returns, when locked safety lamps and permissible explosives are used exclusively. In mines where open lights and black blasting powder are being used, the maximum percentages of both methane and carbon dioxide should be 0.3 per cent., in all returns.

In actual practice I have found that 1.5 per cent. to 2 per cent. of methane is explosive when mixed with dry coal dust floating in the atmosphere, the observations being taken in a mine at a temperature of 47 deg. F.

Professor Heise observed the minimum explosive temperature of methane to be 1112 deg. to 1292 deg. F., the maximum temperature being 4802 F. The most violent explosions occurred when air contained 9.5 per cent. of methane, oxygen being present in sufficient quantity to allow complete combustion. It has been observed that the quantity of firedamp in gaseous mines increases in many cases nearly proportionately to the extension of excavations, provided there are no outlets to the surface for the gas in sections which are being robbed.

WHAT IS A GASEOUS MINE?

The question has often been asked: "What is a gaseous mine?" Any mine is gaseous which liberates explosive gas; whether that gas will affect a safety lamp or is only revealed by a chemical analysis. I would like to suggest the following as a mode of determining whether a mine is really gaseous. Shut down the fan and close the intake and return airways for a period of 24 hours; if the chemical tests of the air in the mine do not show methane to be in the atmosphere in excess of 1 per cent., then the mine is liberating firedamp in such small quantities that the operator should not be compelled to employ a fire-boss or bosses, provided that similar tests are made monthly and that the fan is of approved size to supply ample ventilation and is kept in operation day and night to insure a safe and good quality of air.

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*Abstract of a paper by Karl F. Schoew, Mine Inspector, first inspection district W. Va., read before the West Virginia Coal Mining Institute, Charleston, W. Va., June 6, 1912.

DANGERS OF TORNADO VENTILATION.

There is no advantage in excessive quantities and rapid currents of air. Some mines are liberating explosive gases in such large quantities that we cannot dilute them with fresh air to such an extent that they cannot be detected by chemical tests. Moreover, during the cold season of the year, such excessive quantities of air could not practically be heated by steam, so as to be capable of carrying sufficient moisture into the mine to keep the coal dust wet. The larger the current of unsaturated air traveling through a mine, the faster the dust is dried up.

GAS WHICH GIVES NO SIGN.

In the mines of our state from 0 to 600 cu. ft. of methane is liberated per minute. As there is an ever present danger that natural gas will escape from gas wells into the mines, and that gas blowers will be encountered in the advanced working places, chemical tests of the mine air should be made at least once a month in every gaseous mine to ascertain whether there is ample ventilation provided to dilute what is being liberated. In non-gaseous mines chemical tests should be made at least every three months. The State mining department should keep records of the results of all these tests as made in both gaseous and non-gaseous mines.

Chemical tests of mine air would prove to be an eye-opener to many operators. Although the mine and fan may have been idle for a day, the intakes and returns of the mine closed and no fire-damp detected with a safety lamp or with an open light, this by no means establishes the fact that the mine is entirely free of explosive gas; for as much as one per cent. of methane would not be detected by a fire-boss, and it would not burn if an open light were put into the mixture.

TEMPERATURE AND MOISTURE.

From a standpoint of economy, safety and promotion of health, air entering live working places and gobs should by all means be adjusted to natural mine temperature, which, in our state, is about 57 deg. to 60 deg. F., and should contain a minimum percentage of 94 per cent. humidity. Brattice cloth only begins to show slight moisture at 94 per cent. of air saturation at the natural mine temperature, while at about 96 per cent. humidity it is thoroughly wet to the touch. Coal dust exposed to 90 per cent. humidity at mine temperature will appear dry to the observer.

A few hygrometers placed at the mouth of inlets to butt entries will prove beneficial. These should be read by the fire-bosses and the reading reported twice weekly. If necessary, additional steam could then be passed into the air. If the mine temperature be kept at 57 to 60 degrees, and 94 to 100 per cent., saturated, considerable expense from roof-falls will be obviated, because these in many cases are due to sudden changes in mine temperatures. It would also prevent mine fires, as all combustible material would be kept thoroughly wet. The effect of over-heated air currents in mines, as we all know, is to reduce the powers of body and mind, especially when concurrently the air is saturated with moisture. At a certain temperature there is a decided change in the human body.

FIFTY-FIVE DEGREES THE HEALTHY TEMPERATURE.

On all Fahrenheit theremometers 55 degrees is marked as temperate, which is merely the natural temperature of the West Virginia mines. Above 55 degrees we require little warmth, and this is supplied by a little exercise. When the air is colder, it is probable that the conducting power is too great for the amount of heat developed. At any rate, the point in question is one to be noted, and it appears extremely reasonable that the ability to labor will be diminished as the heat varies much above or much below 55 degrees. The aim should be to maintain the natural mine temperature all the time. Whenever the temperature in a mine is left unadjusted, the necessity for adjustment is felt.

The human body demands warmth above all things, and it is the very first demand, as no function can be satisfied without it. No doubt a person may live for days, perhaps years, in badly ventilated places, with more or less discomfort or danger to health. The danger of cold, besides many others, confronts mine workers in mines where during the cold season exhaust fans are used, so that the intake cannot be heated. The great instinct of man is to keep warm. Adjusted mine air, be it at full saturation, or near that point, feels comfortable, and is a great agent in the purification of the atmosphere. Coal dust and solid particles of powder fumes are quickly washed out of the air. Thus the mine is speedily made free of this menace.

Blackdamp can readily be dislodged in live workings and gobs by ventilating with air which has been adjusted, and is therefore fully or nearly saturated. Each gallon of moisture introduced by this means is capable of observing equal volumes of carbon dioxide.

WHERE MOISTURE IS HARMFUL.

Moisture does cause an increase in fatality in some countries. It does this if there is no wind to agitate the humid air, and no rainfalls to wash it clean. When we are exposed to fog and humidity, with no wind to agitate them and no rain to wash the impurities out, it is not hard to understand that the atmosphere is harmful. But these conditions do not exist in our mines. The air is moving, and although it may be fully saturated, as soon as the dew-point is reached, the moisture drops like rain, and cleanses the atmosphere.

I have observed during my experience as a mine inspector that properly adjusted mine air, although fully saturated with moisture, has no injurious effect upon miners. Fresh air is a good investment, whether it be in an office or in the mines. Without it the most energetic lose force and cannot do a full day's work. A miner cannot develop his utmost power without fresh air, any more than can the fire under a boiler yield the utmost heat when deprived of the necessary amount of good air.

KEEP THE MINE AIR MOVING

BY D. G. THOMAS.

I was sitting in the entry,
Humming low a fancied song,
While my fevered brow was cooling,
In the air that rushed along,
Through the dreary, darkened chambers
Where the deadly lurking damp
Lingers harmlessly till startled
By the flame on some one's lamp.

The pick, pick, pick of the miners
I heard in the chambers afar,
Like the noise of cracking muskets
When the soldiers are at war;
Now and then a sound like cannon
Roared out with a lurid glare,
When a blast, red-tongued, exploded
And rolled on the vibrant air.

Onward—the current moved onward,
Swiftly and coldly it flew
Into the farthest recesses
Still keeping constant and true;
Hurrying past me it murmured
In language careless and free:
"O man, thy life shall be forfeit
If thou for a moment stop me.

"Make room for my wings, O mortal,
Make room for my wings to fly
With breath for the panting toilers
Or they will perish and die;
Stand not in my way for an instant,
Obstruct not my hard-worn path,
Or the gas that I should make harmless
Will flame in its awful wrath.

"When the world was in disorder,
Ere the days and night began
Changing cycles with each other,
Long before the birth of man,
I was constantly in motion,
Making ready all the earth
For the coming and the welcome
Of humanity's proud birth.

"Then I lived to be man's servant
Both on land and on wave,
Doing wonders at his bidding,
Working like a faithful slave;
Driving clouds across the heavens
When he needed cooling rain;
Then dispelling them that sunshine
Might smile on the earth again.

"Now they take me in the darkness
Where the Devil's imps abound;
There to kill the gas that gathers
Like a stealthy foe around,
Waiting to disclose its presence
When a flaming lamp is near
To ignite it, then to hasten
On its wild and mad career.

"Keep my passageway wide open,
Make me sing as on I go,
Then the gas that I encounter
Meets an unrelenting foe;
I alone can make it harmless,
Make it shudder, break and flee,
And in safety keep the miners
That depend for life on me."

—*Coal Age.*

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MAGAZINE

EVERYTHING PNEUMATIC

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AIR COMPRESSOR CLASSES

The capital letter class designations of the various types of air compressors, as Class A, Class G, Class O, etc., are apt to be somewhat puzzling to the uninitiated; but they mostly have not been adopted arbitrarily, and generally they stand for or suggest something of more or less importance to be remembered.

A few of these class letters are initials of descriptive words, as B for belt-driven, C for some Corliss feature, D for duplex, and so on; but besides these, and ultimately more significant than these, are the letters which mark the successive steps in the history of the air compressor, its progressive development in the direction of increased power economy, efficiency and general adaptability.

Class A stands for the type of compressors first built and now represents almost ancient history, while the other letters have been employed in alphabetical succession when radical departures in design and construction have occurred, and now O and P and their neighbors belong to the compressors of most recent type, embodying the latest and most approved features. Further along we may have Class T for turbo-compressors, which letter will then have the double embodiment of the actual initial and of the historical sequence.

There was a time when Class A was the only type built, and when its designating letter, not being needed, had not yet been applied to it; and all concerned were, perhaps, as well satisfied with it and with its performance as now we are with the machines whose letters are approaching the other end of the alphabet. But what a distance it seems that we have traveled from our original compressor ideals! Not only have the compressors been gradually improved, the builders' ideas enlarging as their work has grown, but, most important of all, the customers have been educated, so that those who buy and use the machines require much better performance than those of old to satisfy their demands.

This has retroacted, so that while machines are still built which are nominally Class A they are very different machines and make a much better showing than those whose successors they claim to be could ever have done. The first steam-driven compressor, which, looking backward, we now call Class A, was a plain slide-valve steam engine without cut-off or anything else, and the air cylinder, partially water-jacketed under compulsion, worked single-stage, and the machine was started and stopped by the engineer, or slowed down by hand as far as possible, according to the fluctuations of the air pressure, so that if it would only work at all and supply the air at any cost that was all that was asked for.

The up-to-date compressor is something not only for the builder to be proud of, but for the miner or contractor to regard with good-will and satisfaction. High-pressure steam, Corliss (or equivalent) compound condensing engine, two-stage air compression with precooling and air filtering arrangements, complete water-jacketing of cylinder, intercooler and water eliminator between stages, aftercooler, automatic regulation of air volume according to requirements, and adjustment of power to work, reliable lubrication throughout—these are now the familiar devices of every-day practice; and it is no wonder that air compressed and delivered costs per unit of volume only a third or a quarter as much as it generally cost only twenty or twenty-five years ago.

In the operation of the steam-driven air compressor as a whole the percentages of savings are, of course, worth as much at one end of the machine as at the other; and it is a rather curious thing that, as a result of the various improvements which have developed, the actual savings in practice have been much the larger at the steam end of the machine. No strikingly novel additions to our knowledge of the properties of steam have developed; but the compressor people, builders and users alike, have finally realized that it pays to save steam in compressing air as well as elsewhere.

TEN TIMES AS GOOD

Editor Compressed Air Magazine:

We respectfully call attention to an article published in the June issue of COMPRESSED AIR MAGAZINE entitled "Commercial Value of the Air Lift," by F. S. Miller.

On page 6462 is given an example showing the cost of pumping with compressed air, or the 20th Century System, in which the cost of coal per ton is assumed at $2.00 and the cost per pound as 1 cent, which latter is a mistake. It should be $0.001 per pound, which would make the fuel cost per hour $0.027, or, pumping 6000 gallons per hour, $0.0045 per 1000 gallons.

This is very different from $0.045 per 1000 gallons, and we trust that you will be able to make correction of this error, as the article as published will not give a very favorable impression of the 20th Century Air Lift System.

HARRIS AIR PUMP CO.

Indianapolis, Ind.

THE BOILING POINT OF FROGS

The following we have already noticed in several of our exchanges. It is going the rounds with some moral tagged on to it by the advertising sharps:

"A frog jumps readily enough when put into warm water, yet a frog can be boiled without a movement if the water is heated slowly enough. In a physiological experiment at Yale University the water was heated at the rate of .0036 of a degree a second, Fahrenheit. The frog never moved, and at the end of two and a half hours was found dead. He had evidently been boiled without noticing it. There are hundreds of business frogs, etc., etc."

As we figure it, the temperature of the water, according to the data given, would have been raised 32.4 degrees, so that the poor frog must have been in pretty hot water to begin with.

A RIVER TUNNEL IN AN OPEN CUT

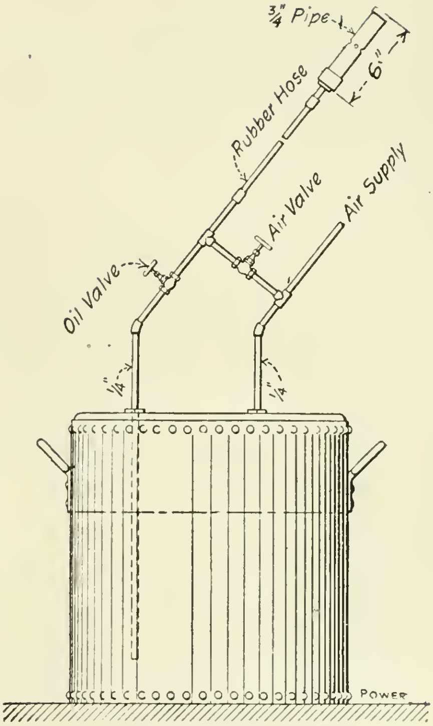
At Berlin a tunnel which is to carry the underground railway beneath the river Spree, is being built in open cut within cofferdams, and the work has been divided into two sections. The length of the river crossing, exclusive of approaches built in open cut, is about 430 ft. Half the width of the river was first closed by two parallel cofferdams 75 ft. apart and an end cofferdam at the middle of the river. The enclosed space was excavated and drained, and the double-track reinforced-concrete tunnel of rectangular section was then built. A second end cofferdam or bulkhead was then built back of the first one, the two (with the side walls connecting them) forming a pit around the head of the tunnel, which was closed by a temporary concrete bulkhead wall. The cofferdams from the shore were then removed, and similar cofferdams built from the opposite shore to the island cofferdam left in place at the middle of the river. This second enclosed space was then pumped out and excavated, and the second portion of the tunnel built.

HOW PIECEWORK WORKS

At the last annual convention of the American Wood Preservers' Association, the secretary, F. J. Angier, who is superintendent of timber preservation of the Baltimore & Ohio, told about the establishing of piecework rates at a timber-treating plant on the Burlington in South Dakota. At the time this system was installed they were handling ties on a day basis, paying 17½ cents per hour. A gang of ten Swedes was secured and they were placed under a good foreman, who was instructed to see that the men worked steadily and gave a good day's work. The record of the number of ties handled was carefully kept for a week and this number divided into their total wages gave the cost per ties on a day basis. This gang of Swedes was then placed on a piecework basis with a rate a trifle less than had been paid on the day basis. The result was that they very quickly increased their monthly wages until they made from $75 to $90 a month where they had previously made about $45. The company did not decrease the rate, as with the increased output the cost of the work to the company was lessened, because of the reduction in the cost of the foreman's supervision and overhead charges.

AIR FILTERS IN CYANIDING PLANTS

The compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is passed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well-known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.



Oil Spraying Outfit

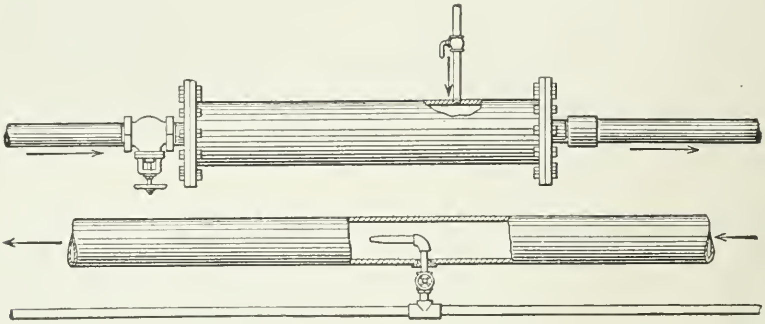
OIL-SPRAYING ABSORBER TUBES

Every refrigerating engineer has been troubled with leaking absorber tubes while the machine is in operation and in getting the scale out of the tubes when the machine is shut down for winter repairs, but much of this trouble can be avoided by spraying the inside of the tubes with raw linseed oil. They should first be thoroughly cleaned with a flue scraper; then the oil may be applied to good advantage with an oil spray using air. I use the apparatus shown in the sketch. The tank can be placed on top of the absorber and the air piped to it.

This apparatus can be made very cheaply, using any tank that will stand a pressure of from 50 to 60 lb. The sprayer is made of ¾-in. pipe for 2-in. tubes and ½-in. pipe for 1½-in. tubes, drilled with four ⅛-in. diametrically opposite holes. To obtain a good spray and not waste the oil, the oil and air valves must be properly adjusted.

After spraying the tubes let water flow slowly into the bottom of the absorber to give the oil on top of the water a chance to cover any unoiled place on the tubes as the water rises.

If this treatment is employed there will be fewer leaks during the season, the scale will not form so thickly on the tubes and they may be more easily cleaned when the machine is shut down for repairs.—*Power.*



A WATER BLAST FOR DUSTY MINES

The cut shows what is known as the James water blast which has been developed in South Africa and now is used in many mines on the Rand. It is intended especially for allaying dust and absorbing noxious powder fumes immediately after blasting.

There is a piece of 6-in. pipe about 10 ft. long closed at each end by a flange which has a central hole threaded for 2 in. pipe so that it can be connected into a 2-in. compressed air main anywhere. A hole in the side of the 6-in. pipe is threaded for a small pipe to connect with a supply of water under low pressure. This may be obtained conveniently by providing a tank or cistern for water storage in some part of the mine above the level in which the water blast is used.

A valve in the 2-in. service pipe and in the small water supply pipe are used to control the flow of air and water. While drilling is going on the air valve is left wide open, but the water valve is closed. When ready to blast the miners close the air valve and open the water valve; the 6-in. cylinder is quickly filled with water. As soon as the blast has been fired the air valve is opened suddenly, causing the water contained in the 6-in. pipe to be ejected into the face of the drift in the form of a fine spray.

The spray of water is effective for a distance of 30 or 40 ft. back from the face. To promote further ventilation an induction draft pipe as shown in the sketch may be used to delived air at the face or to withdraw air from it. The water blast not only allays the dust made while blasting, but wets the broken material so thoroughly that little or no dust is raised by shoveling.

IMPOSSIBLE GASOLENE EXPLOSIONS

Recently Joseph Stubbers, of Cincinnati, gave a demonstration of the difference in hazard of gasoline as a liquid and the vapor of gasoline mixed with air.

"There is no more danger of gasoline exploding than if it were so much water," he said, pouring burning gasoline from one can to another while the flames played about the stream of burning liquid as it descended from one can to the other. "Gasoline in liquid form never explodes, it just burns like so much oil," he added as he poured some of the liquid on the floor, set two cans of the gasoline on the wet spot and then applied a match just as the observers were closing the door behind from the outside, yet no explosion followed. Instead the gasoline burned briskly on the floor and all about the filled cans which by this time had caught fire at the spouts and were burning like torches. "It's all in the way you handle gasoline," added Stubbers, as the spilled gasoline on the floor burned itself out and only the torchlights remained burning in the spouts of the cans of liquid gasoline. "You are safe as long as you do not give the gasoline a chance to vaporize; it's the vapor that explodes and not the liquid gasoline. A few drops of gasoline vaporized and mixed with the right quantity of air is enough to start something."

Then Stubbers took an empty can and allowed a few drops of gasoline to trickle down through the spout. Then he shook it vigorously to vaporize the gasoline and mix it with the air in the can. "Now we have the right amount of air and gasoline vapor to start something," he said, and held a match to the opening in the can. Immediately there was a deafening report and a flame shot from the can. "Now to show you that the liquid gasoline will not explode I will fill this same can with gasoline within two inches of the top and apply a match as before." The flame burned placidly about the mouth of the can like an alcohol flame. Picking up the can and blowing into the spout, the flame shot out high into the air as long as Stubbers blew into the spout. On ceasing the flame immediately went back to its source and burned as before.

"There is no such a thing as a gasoline explosion," said Stubbers, "it is a gasoline vapor explosion in every case, and when you read of a 'horrible gasoline explosion,' believe me that some one has been careless in handling gasoline and has allowed the liquid to vaporize into the surrounding atmosphere in the room just as we mixed those few drops with the air in that can." In illustration of this Stubbers extinguished a burning wax taper by inserting the burning end into a can of gasoline. It went out with a sputter just as it might if immersed in so much water.—*Insurance Magazine.*

OZONE STERILIZATION

Ordinarily sterilizing agents are not always pleasant, but there is a fascination about the use of "electrified air." There are no repugnant residues after ozone has attacked organic matter, whether it be in drinking water, in the air or on hospital bandages. In other words, ozone burns up decaying and dangerous organic matter into harmless products.

This magic gas, merely oxygen in a more active form, is obligingly made for us by nature through the action of the sunlight and electric stress in the atmosphere. But so quickly does it pounce upon dirt, that around cities we find little or no ozone. Some authorities consider it nature's purifier. Man has learned to imitate one of nature's methods of making it, and now many types of electric ozonizers are on the market, all depending on the fact that when electricity under a pressure of several thousand volts jumps silently across an air gap, part of the oxygen in the air is converted into ozone.

One part in a million of air is bracing in its effect, the results being like those of the best mountain air, and the organic sewage thrown off by people's lungs is readily burned up. This air sewage is the cause of stuffiness, headache and depression when people crowd together indoors. It is a genuine poison; but ozone renders it harmless. In this connection it is well to take the claims of manufacturers of ozone machines with a grain of salt. Enough ozone to kill bacteria in the air will be extremely unpleasant if not positively injurious. Its value in improving the air of churches, theatres and houses lies solely in the destruction of air sewage. Indirectly, this keeps down the number of bacteria; for they need the air sewage as food, and the oxidation of their food checks their increase.

The stimulating effect of slightly ozonized air is like that of the pine woods or mountains or seashore, and possibly for the same reason. Physicians in London and Paris report great benefit by its use in cases of anemia, incipient tuberculosis, whooping cough, etc. Recently a completely equipped hospital for the study of ozone as an aid in therapeutics has been installed in London.

To purify drinking water greater concentrations are required, too great for safe or pleasant breathing. The highly ozonized air is mixed with the water and kills bacteria as well as removing odor and taste from very bad water. Muddy water is rough-filtered first. One hundred cities in Europe including Paris and St. Petersburg are purifying their municipal supplies in this way. Paris has a plant at St. Maur with a capacity of twenty million gallons in twenty-four hours. A few plants are in operation in America, notably in Baltimore, Ann Arbor and Linsay, Ontario. A Chicago firm sells a small ozonizer to be attached to the household faucet. It consumes electricity only when the water is running.

As a deodorizer ozone is wonderful. Public toilets, club rooms reeking with cigar smoke, storage cellars, restaurants—all respond to this means of purification. A large number of banks and other business houses stimulate their clerks to their level best by making the air invigorating with a dash of ozone. The cost of running a machine adequate for a church or small theatre is no more than that of two sixteen-candle power lights. One hundred and fifty dollars will buy a large machine, and household sizes may be secured for less than fifty dollars. Leading hospitals sterilize bandages and instruments by exposure to very strongly ozonized air. As an adjunct to the cold storage preservation of fruit there are great possibilities. Less refrigeration is required if the atmosphere is charged with ozone, for it prevents the growth of the organisms of decay. Brewers already use the gas to sterilize casks and vaults, and to some extent to age beer.

Outside the bactericidal field ozone has a commercial use as a harmless bleaching agent. Flour, for example, has been whitened by nitric oxide gas; but the determined opposition of the government pure food department has directed attention to the fact that ozone will bleach the yellowest wheat flour to a pure white with no possibility of danger to the public health. For that matter sugar, oils, starch, textiles and the delicate ostrich plumes are thoroughly and safely bleached.

A great drawback to the more general use of this valuable gas is its extreme instability. Cylinders of it cannot be shipped as can be done with oxygen, for, unfortunately, ozone rapidly decomposes into the oxygen from which it was made. Heat and moisture are both unfavorable to its preservation. The Steynis system of making large quantities of it for industrial use avoids this danger to some extent. In this process the air to be treated is first dried and chilled.

Investigation in this field has received a tremendous impetus in the last decade, and much more is to be expected in the next.—*Scientific American.*

NOVEL AIR COMPRESSOR EXPLOSION

The following is from a Montreal correspondent of *Power.* The writer says nothing of the grade or the quantity of oil that had been used for lubrication, but it seems to have spoken for itself.

"New piston rings were to be put in the piston of the air cylinder. The compressor was not shut down until everything was ready for doing the job quickly, when the discharge valve was closed and the nuts removed from the cylinder head. A chisel was used to force the head from the cylinder and a lighted candle placed on the engine bed to see to work. As soon as the head was loose from the cylinder, gases within, caused by lubricating oil, ignited, blowing the head from the studs and breaking two adjacent pipes. Luckily these were only a 1-in. water pipe and a 1½-in. steam pipe under very low pressure."

STROKE COUNTER FOR COMPRESSORS

At the power plant of the St. Louis Smelting & Refining Co., in southeastern Missouri, the stroke counters on the air compressors are connected with the low-pressure air cylinders. This allows the placing of the counter with the other indicators on the main gage-board of the engine. A ¼-in. pipe is tapped into the low-pressure air cylinder and is carried over to a small cylinder on the main gage-board. The piston of this cylinder rises and falls with the pressure in the main cylinder, and the counter is in turn operated by the movement of the piston in the auxiliary cylinder. This enables the assembling of all indicators in a handy, practical manner on the main gage-board and enables easier watch to be kept of everything in connection with the work being done by the engine.—*Engineering and Mining Journal.*

NOTES

One of the "Imperator's" immense rotors contains 50,000 blades, weighs 135 tons and can develop 22,000 hp.

For the mining city of Broken Hill, Australia, a reservoir has been planned to impound 3,483,600,000 gallons with an area of 380 acres, the annual evaporation from which is estimated at 772,800,000 gallons, or over 2,000,000 per acre.

A blackish incrustation, in some places four inches thick, on the under side of the cornice of St. Paul's Cathedral, and due to the action of sulphuric acid upon the stone, testifies to the effects of the smoke evil in London.

Experiments have shown that unless there is an unusually large amount of dust in suspension in the air, ignition does not take place from a naked flame. Dust explosions are the result of violent compressions simultaneously with the production of a large flaming area by the explosion of a charge.

Winnipeg, Canada, is said to be one of the leading cities of the new world in the matter of municipal ownership. Among the municipally owned public utilities are an asphalt plant, a stone quarry and a plant for the laying of cement sidewalks.

It is claimed that soap water used instead of ordinary water in mixing concrete makes it waterproof. A grain elevator, at times exposed to inundation, was built in Germany from reinforced concrete made with soap water, and this building was successful in withstanding the effect of the water, while another building of the same material, but having been made without soap water, failed to completely keep out the water.

The Strawberry Tunnel of the U. S. Reclamation Service in Utah was holed through on June 20. This tunnel, which pierces the Wasatch Mountains, is 19,200 ft. long and will deliver water from Strawberry River to 70,000 acres of rich agricultural land located 65 miles south of Salt Lake City. Preliminary work was begun during the fall of 1906, and tunneling was started in the summer of 1908. The driving was all done from two portals, for the profile of the line is such that shaft and intermediate headings were not feasible.

The engineer corps of the U. S. Army, which is charged with river and harbor improvements in addition to many other lines of work, now has floating equipment nearly as numerous as vessels of the navy, approximating in all 855 craft of all sizes. Of these no less than 137 are dredges which are large coal consumers and practically every other boat in the fleet is a user of coal on a considerable scale, for the activities of the department may be gleaned from the fact that in the past fiscal year the dredges excavated 52,000,000 cubic yards of material, or about five-sevenths as great a volume as the entire contents of the Culebra cut.

In Holland they are using a pump to convey the beets to the sugar factory, As many of the beets are hauled by barges, the men in charge just throw them overboard, the beets reach the pump by means of a flume, and are then pumped into position, which washes the beets at the same time. When a stoppage occurs in the pump the ordinary pressure of from 0.7 to 0.9 atmospheres is increased to 2 atmospheres by shutting off a slide. At Viervlaten one of these pumps has been installed and has a capacity of 440,000 kilograms, 968,000 lbs., in 24 hours.

Thomas Mitchell, foreman of the Leonard mine in Butte, Mont., recently applied for a patent on a dust eliminator for drilling machines. The appliance, which is simple, has four heavy iron fingers which are attached to a cylindrical ring. The fingers are set as a spring and fit in the hole. A canvas tube leads from the ring through which the dust falls while another short canvas tube covers the drill. The apparatus does not conflict with the changing of the drills and the entire device can be manufactured for less than 50 cents. The appliance has been given a thorough workout in the Leonard mine and has proven satisfactory.

Coal barge number 742 of the Reading Coal company recently passed through the draw of the old stone bridge spanning the Neponset River, Mass., loaded with 1,000 or more tons of coal. In an attempt to return a few days later the same way when empty it was found that the barge was five inches wider than the passageway through the bridge which she had negotiated safely but shortly before. It was explained by those in charge of the job that the weight of the coal along the keel caused the sides of the barge to spring inboard, and when the coal was removed the steel frames returned to their normal position, increasing the beam of the barge at least half a foot. The external water pressure when the boat was loading probably had as much to do with it.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 4.

1,028,098. PRESSURE-REGULATING VALVE. JOSEPH P. DELANEY, Pittsburgh, Pa.

1,028,121. PNEUMATIC WATER SYSTEM FOR DOMESTIC PURPOSES. Herbert M. Lofton, Atlanta, Ga.

1,028,128. POWER-TRANSMISSION MECHANISM. Robert C. Mitchell, Mount Vernon, N. Y.

1. In an apparatus of the character described, a driving shaft, a driven shaft, a planetary wheel connection, a carrier therefor, and a fluid controlled means with external circulating pipes whereby the movement of the carrier may be varied and maintained with substantial uniformity at any desired speed.

1,028,145. RECORDING APPARATUS FOR MEASURING GASEOUS FLUIDS. Carl Friedrich Simon, Stolberg, Germany.

1,028,201. PROCESS OF PRESERVING WOOD. Carleton Ellis, Montclair, N. J.

1. The process of treating wood comprising subjecting wood to a preservative oil under pressure and then to the action of a fixed gas under higher pressure, said gas carrying less oxygen than normal air.

1,028,209. AIR-LIFT PUMP. Otto E. Harris, Indianapolis, Ind.

1,028,373. PRESSURE-MEDIUM CONTAINER. Harry M. McCaslin, Elmira, N. Y.

1. A device of the character described, comprising in combination a container for compressed fluid, having a fluid passage, a sealing nut therein having a recess forming a continuation of said fluid passage, and a puncturable sealing diaphragm constituting a control valve carried by said sealing nut and seated and unseated thereby to close and open the container during charging.

1,028,511. ATMOSPHERIC ENGINE. Albert R. Weisz and George R. Weisz, New York, N. Y.

1,028,623. AIR DRILL-SOCKET. Robert J. Smith, Yonkers, N. Y.

1,028,628. TIRE-INFLATING APPARATUS. Mason F. Stolberg, Toledo, Ohio.

1,028,652. DOUBLE-SEAMING AND VACUUMIZING MACHINE. Ludwig Wurzburg, San Francisco, Cal.

2. An apparatus of the character described, having a chamber, means for exhausting air from said chamber, a rotary can carrier in said chamber, means for rotating said carrier, means for introducing cans in succession into said chamber while maintaining a vacuum therein, means for causing said cans to be engaged by said carrier to be transported thereby, and means for seaming said cans while being so carried, substantially as described.

1,028,665. PUMP. Achille Bertelli, Brescia, Italy.

1. In a pump of the class described, the combination of a well tube, a pipe fitting in the well tube and communicating with the latter, means for sealing the upper end of the well tube, a suction pump connected with the pipe, an upwardly tapered air injecting tube centrally disposed in the pipe, and means for forcing a continuous supply of air through the tapered air injecting tube.

1,028,722. PNEUMATICALLY-CONTROLLED DRAIN-VALVE. Martin H. Hess, Davenport, Iowa.

1,028,740. CUSHIONING DEVICE FOR VEHICLES. Theodore A. Klenke, New York, N. Y.

1,028,793. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind.

JUNE 11.

1,028,862. SLIDE-VALVE FOR AIR-MOTORS. William F. Cooper and Edward P. Chase, Norwalk, Ohio.

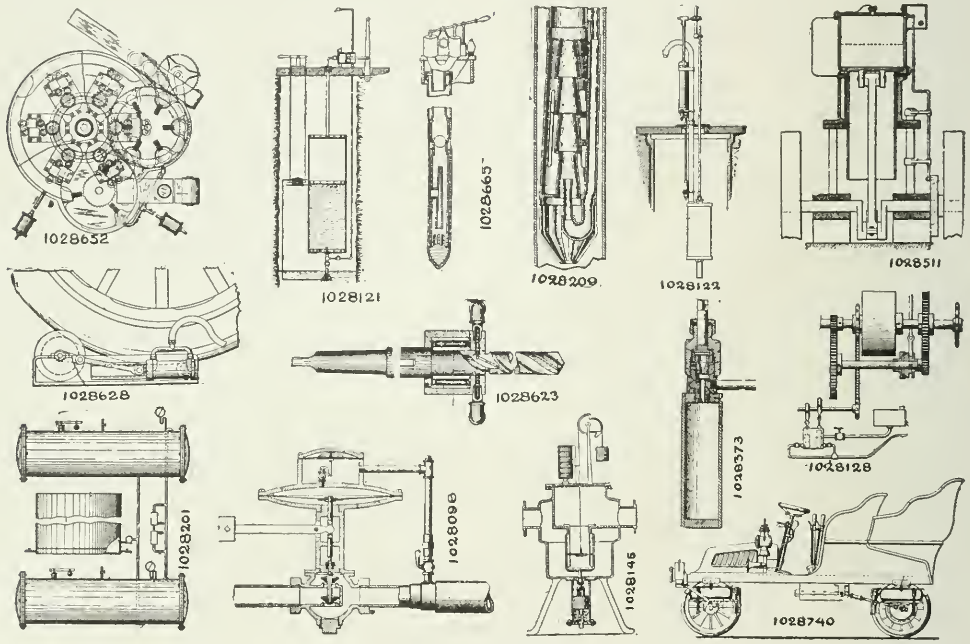
1,028,939. FLUID-BRAKE FOR RECOIL-GUNS. Walter Heilemann, Essen-on-the-Ruhr, Germany.

1,028,994. BUBBLE-BLOWER. Frank H. Cordtmeyer, New York, N. Y.

1,028,997. POWDERED-FUEL-FEEDING APPARATUS. William R. Dunn, Easton, Pa.

1,029,025. INLET-VALVE FOR COMPRESSORS. Harry D. Murray, Grove City, Pa.

1,029,082. PNEUMATIC IMPACT - TOOL. Charles K. Pickles, St. Louis, Mo.



Pneumatic Patents, June 4.

1,029,097. VALVE. Harry E. Atkinson, Traverse City, Mich.

1,029,186. POSITIVE BLOWER. William W. Green, Niles, Mich.

1,029,201. REFRIGERATING-MACHINE. Maurice Leblanc, Paris, France.

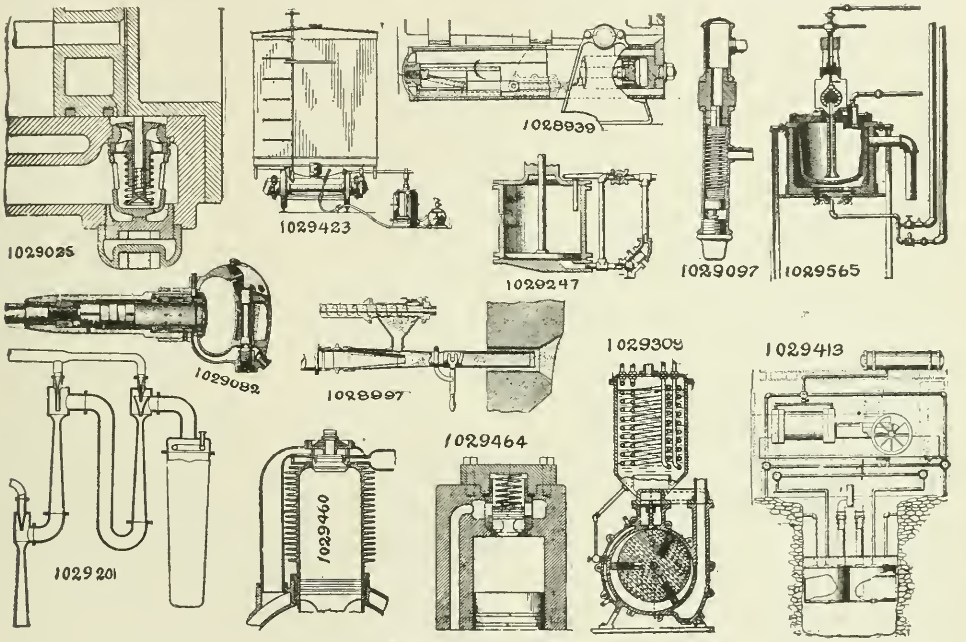
1,029,247. PNEUMATIC CUT-OFF FOR DUMP CARS. John W. Wilcox, Chicago Heights, Ill.

1,029,294. ROCK-DRILL. James Miners Holman and John Leonard Holman, Camborne, England.

1,029,309. AIR AND GAS COMPRESSOR. Casper W. Miles, Anderson township, Hamilton county, Ohio.

1,029,368. AIR-BRAKE. George W. Hohn and Edward G. Reisinger, Butler, Pa.

1,029,413. PUMPING APPARATUS. Friend A. Allen, Granger, Mo.



Pneumatic Patents, June 11.

1,029,421. ACTION FOR PNEUMATIC PIANO-PLAYERS. Erick V. Carlson, Chicago, Ill.

1,029,423. FLUID-ACTUATED LIFTING-JACK. Willard R. Chandler, Branchville, S. C.

1,029,460. FLUID-PRESSURE ENGINE. Charles Benjamin Redrup, Cardiff, England.

1,029,464. VALVE. William F. Ruwell, Philadelphia, Pa.

1,029,477. VALVE-CONTROLLING MECHANISM FOR TRAIN-AIR-BRAKE-SYSTEMS. Perry T. Strader, Amarillo, Tex.

1,029,489. FLUID-PRESSURE TURBINE. Athol Wilfrid Clarke, Manchester, England.

1,029,565. PNEUMATIC CASTING APPARATUS. Samuel Price Wetherill, Jr., and John Price Wetherill, Jr., Philadelphia, Pa.

JUNE 18.

1,029,599. SANDING DEVICE. Le Berten T. Duncan, Long Pine, Nebr.

1,029,625. PNEUMATIC AUTOMOBILE-WHEEL Oscar C. Olney, Cincinnati, Ohio.

1,029,630. METHOD OF AND APPARATUS FOR CHARGING POWDER. William H. Plummer and John Tresider, Coleraine, Minn.

1. The method of charging powder into a hole which consists in inserting a tube into the hole, placing a quantity of powder in a receptacle protected from sparks, then generating a blast of air and blowing the powder into the hole, substantially as described.

1,029,644. PNEUMATIC SPRING FOR VEHICLES. Arthur C. Vail, Selah, Wash.

1,029,691. BLOWPIPE. William Kirkwood, Chicago, Ill.

1,029,746. VACUUM APPARATUS. Louis W. G. Flynt, Rochester, N. Y.

1,029,779. GLASS-BLOWING APPARATUS. Albert C. Wilcox, Wheeling, W. Va.

1,029,796. APPARATUS FOR PRODUCING AN EXPLOSIVE OR COMBUSTIBLE MIXTURE OF LIQUID FUEL AND AIR. Charles Ernest Dawson, Teddington, England.

1,029,818. OIL-BURNING APPARATUS. William C. H. Noble, Los Angeles, Cal.

1,029,849. FLUID-OPERATED HOIST. Walter H. Butz, North Plainfield, N. J.

1,029,855. ROCK-DRILL. David C. Demarest, San Francisco, Cal.

1,029,862. HIGH-VACUUM ROTARY PUMP. Wolfgang Gaede, Freiburg, Breisgau, Germany.

1,029,916. VACUUM-CLEANER. Constant De Mattia, Detroit, Mich.

1,029,945. PNEUMATIC VEHICLE-SPRING. Thomas D. Quigley, San Francisco, Cal.

1,029,994. PNEUMATIC ENGINE-STARTER. John Allen Heany, Washington, D. C.

1,030,064. FLUID-PRESSURE MOTOR FOR FIRE-BOX DOORS OR OTHER RECIPROCATING MEMBERS. Albert G. Elvin, Somerville, N. J.

1,030,105. FLUID-PRESSURE CONTROL. Frederick E. Martin, Bonami, La.

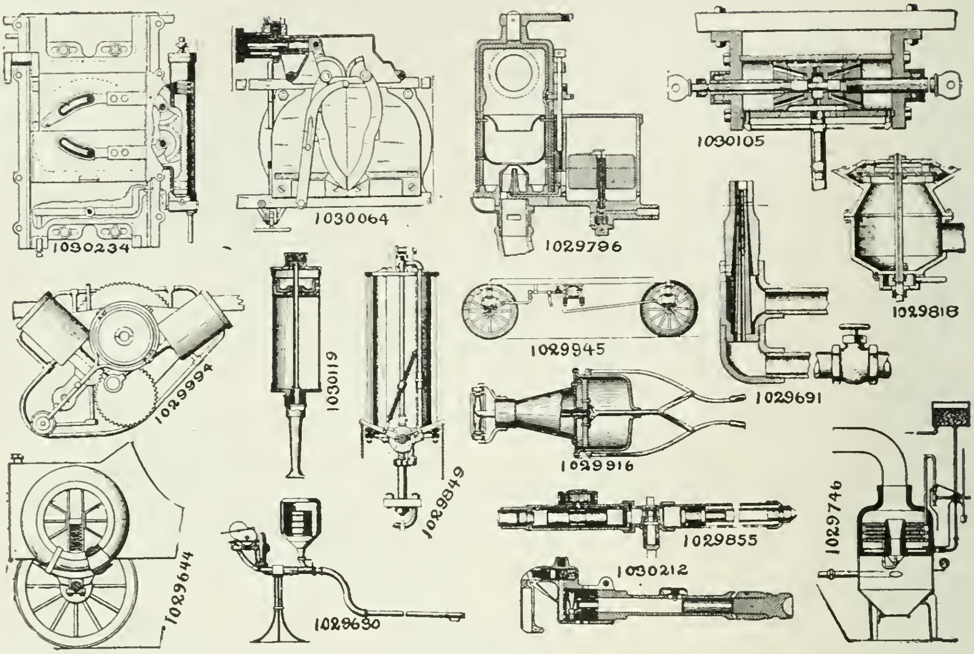
1,030,119. SPRAYER. John Overbeke, Cleveland, Ohio.

1,030,212. PNEUMATIC HAND-HAMMER. Clement Henry Stevens, Las Palmas, Gran Canaria, Canary Islands.

1,030,234. FLUID-PRESSURE MOTOR FOR FIRE-BOX DOORS. Albert G. Elvin, East

JUNE 25.

1,030,416. FLANGING-MACHINE. Hugh McCabe, Lawrence, Mass.



Pneumatic Patents, June 18.

1,030,418. AIR-BLOWER FOR FORGES. John T. McIntyre, Jackson, Ala.

1,030,419. OIL-BURNER. Robert Burns McLellan, Seattle, Wash.

1,030,454. TRAIN-AIR-SIGNAL INDICATOR. Thomas F. Bellhouse, Sacramento, Cal.

1,030,463. FLUID-CLUTCH. Guy G. Crane, Rockford, Ill.

1,030,465. GASOLENE BLOW-TORCH. James E. Flitcroft, Ocean Grove, N. J.

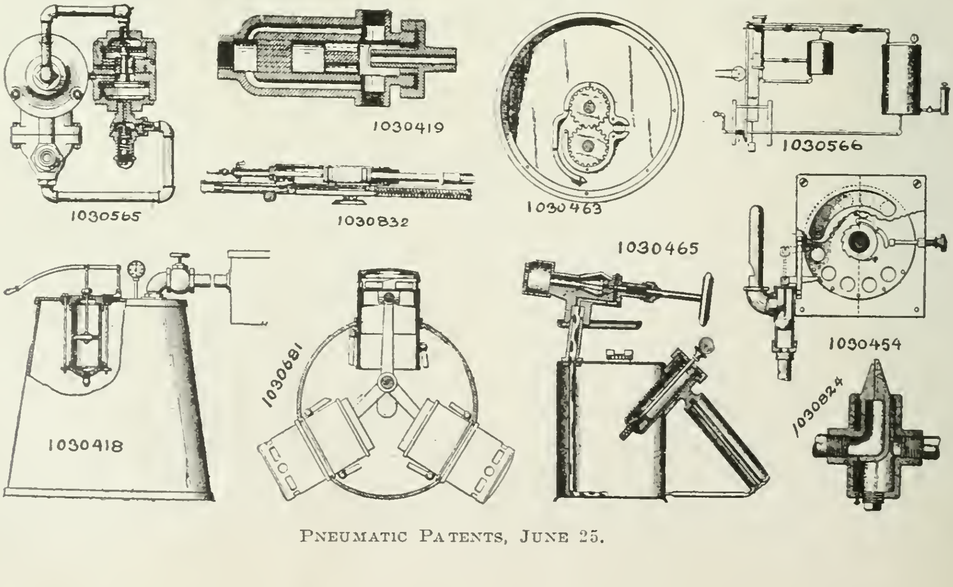
1,030,565. TRAIN-BRAKE. James G. Buchanan, Cananea, Mexico, and John W. Kelker, Los Angeles, Cal.

1,030,566. MECHANICAL MOTOR. George W. Bunting, Ocean City, Md.

1,030,681. CYLINDER FOR FLUID-PRESSURE ENGINES OR PUMPS. Charles Benjamin Redrup, Canton, Cardiff, England.

1,030,824. BURNER. Thomas F. Kent, St. Louis, Mo.

1,030,832. DRILL-ACTUATING MECHANISM. William K. Riley, Los Angeles, Cal.



Pneumatic Patents, June 25.

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Vol. XVII SEPTEMBER, 1912 No. 9

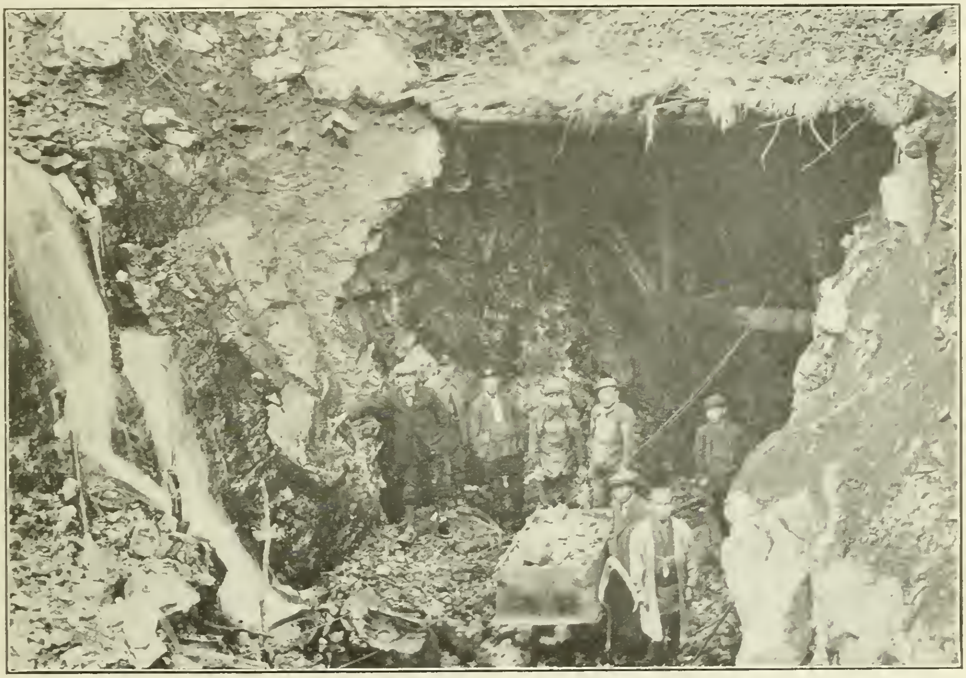

FIG. 1. ENTRANCE TO TUNNEL NO. 20.

ELECTRIC-AIR DRILLS IN JAPANESE TUNNELS

BY CHAS. A. HIRSCHBERG.

A project involving the building of a high pressure power line, 8½ miles long, is being put through between Kurobe and Shimotaki, Japan, by the Kinugawa Hydro Electric Power Company of Tokyo to develop 60,000 Horse Power from the rapids of the Kinu River. The electric current generated is to be transmitted 80 miles to the city of Tokyo.

A 200 foot concrete dam is being built across the Kinu River at Kurobe, from whence the water will be conducted (through tunnels being driven) to Sakasegawa, four miles distant, where a head regulating basin and impounding reservoir are being built of sufficient size to effectually regulate the flow. The spillway of this reservoir will be 40 feet high above the bottom of the head tank located at Shimotaki 4½ miles further distant.

The building of this line involves the driving of 25 tunnels of various lengths 7 ft. x 8 ft. in cross section, in addition to considerable open cut work to carry a flow of 700 cubic feet per second. The available head of water at Shimotaki approximates 1020 feet.

Work was started in April, 1910, under the direction of Messrs. Toshimitsu and Kobayashi, Managers of the Kinugawa Hydro Electric Power Company and Professor Hiroi the Consulting Engineer in charge, and from present indications the project will be completed in the early part of 1913.

Very remarkable speed is being attained in the driving of the tunnels in spite of the very hard rock encountered—a blue blende formation—blue granite and quartz porphyry. An idea of the hardness of this rock may be gained from the fact that from 200 to 250 drill steels are required to put in a round of 13 holes averaging 4 to 5 feet deep.

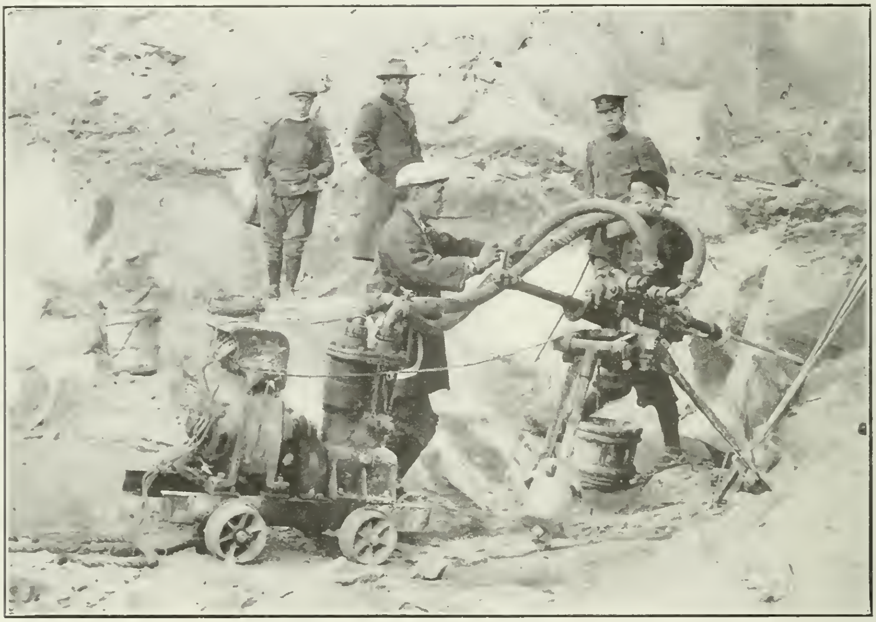

FIG. 2. DRILLING FOR OPEN CUT.

A variety of air driven drills were at first used, air for which was furnished by eleven belted, Class "NE-1" type, Ingersoll-Rand compressors. Owing to the difficulties encountered in the transportation of heavy equipment and the fact that electric current was available the engineers purchased 12 4E Temple Ingersoll Electric Air Drills for part of the work. When the question of additional equipment came up, the engineers conducted a 10 day test to determine just what could be accomplished with various equipment which resulted in the addition of 20 more of this type of drill.

The scene of the test was in tunnel No. 20 and showed an average advance of 12 feet per day of three eight hour shifts, or a total of 120 feet for the ten days. Two 4E Temple Ingersoll drills were used, the pulsators being run in on two 18 inch tracks. Standard mining columns were used for mounting the drills.

The round of holes was drilled as numbered in the diagrams. In blasting, holes 6, 4 and 8, comprising the cut, were spitted first pulling a wedge shaped mass; this was followed by the back holes 1, 2 and 3, then the side holes 5, 9 and 10 and finally the lifters 13, 11 and 12.

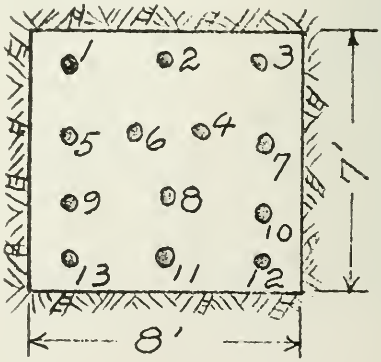

FIG. 3.

One hundred pounds of 70 per cent. nitroglycerine dynamite averaged the consumption per 24 hours. The average time for drilling a 4½ foot hole was 30 minutes including time of changing steels, or a total average drilling time of 6 hours to the round, leaving 2 hours per shift for erecting columns and drills, blasting and mucking. The rock excavated average 224 cubic feet per 8 hour shift, a total of 672 cubic feet per day.

At Tunnel No. 21 similar results have been attained.

In Tunnel No. 15 where the rock is a moderately hard quartz porphyry the advance was somewhat greater, averaging 15 feet every three shifts.

The managers claim that the cost of driving these tunnels with the electric-air drill is considerably lower than that with air drills, while the saving effected through the elimination of compressor plant, pipe lines, etc., has proven very marked on this project.

In conclusion the writer wishes to express his thanks to Mr. T. Yokoyama, Civil Engineer with the Kinugawa Hydro Electric Power Co., for the data furnished.

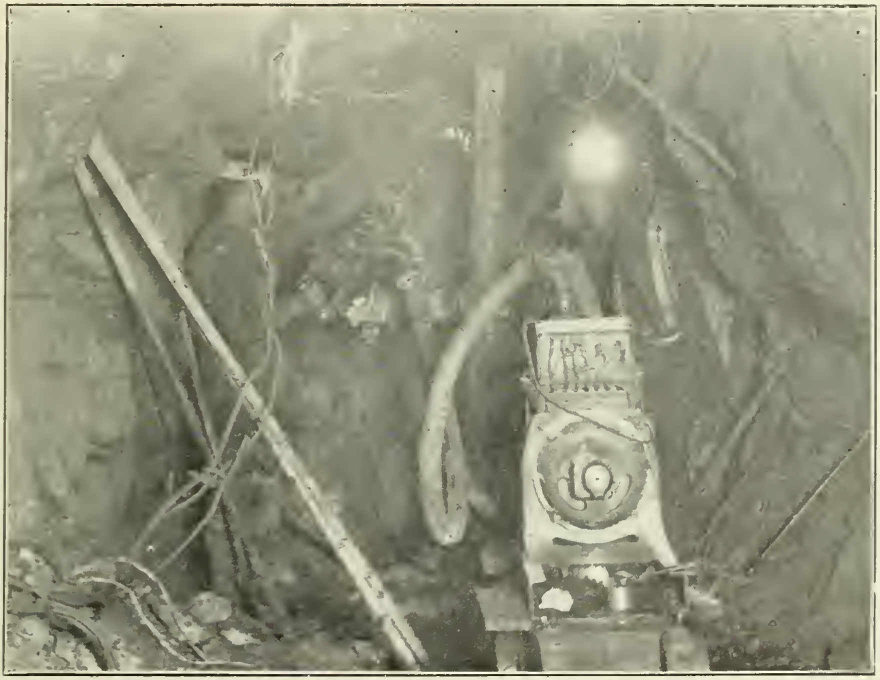

FIG. 4. DRILL DRIVING THE BREAST.

DIESEL AND SEMI-DIESEL DISTINCTIONS

Dr. Rudolph Diesel, in his recent trip to this country, used the following expression: "The Diesel engine is the only engine which converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and which utilizes it as completely as the present advancement of science permits."

In a manuscript for a new book on gas engines, yet unpublished, the following is given as a brief description of the Diesel cycle. "Pure air only is drawn into the cylinder, and this is compressed to a point at which the temperature of compression is equal to or in excess of the combustion temperature of the fuel. The compression is from 350 to 550 lbs. per square inch. Just as the piston starts on the next outward stroke the fuel is forced in under a pressure slightly higher than that in the cylinder. The high temperature of the compressed air causes the entering fuel to take fire and burn as it enters the cylinder, just as gas burns when issuing from an ordinary gas burner. This does not increase the pressure in the cylinder and no explosion takes place. The pressure, however, does not fall so rapidly during the admission of the fuel as it rose during the compression, and the expansion curve is therefore slightly higher in pressure than the compression curve. The exhaust takes place at a pressure near that of the atmosphere, and very little power is lost through the exhaust gases escaping at a comparatively high pressure as they do in the four cycle motor."

The term "semi-Diesel" has, however, come to be applied to engines using heavy fuel oils and operating in a general way on the Diesel principle. Most of these "Semi-Diesel" types are different from the Diesel engine in the manner in which the air is compressed and drawn into the cylinder and in the manner of injection of the fuel. It will be noted that there is a large amount of misconception about what the Diesel type really is. A textbook on gas engines that is considered very reliable refers to the Diesel purely as a four-cycle engine, whereas it is built also in two-cycle units and in very large two-cycle sizes. "Semi-Diesel," therefore, is not a well defined term but is used to designate almost any low grade, liquid fuel engine which does not mix the air and fuel outside of the cylinder.—*The Gas Engine.*

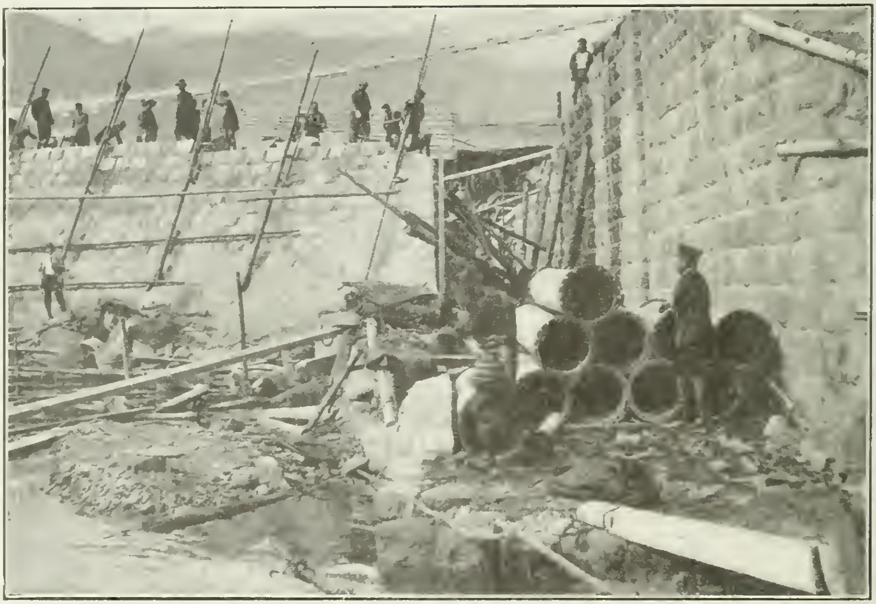

FIG. 5. KUROBE DAM UNDER CONSTRUCTION.

AIR CUSHIONS FOR AUTOMOBILES

The air-cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine Works in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

It is claimed for the new invention that it is adaptable to all kinds of roads, regardless of speed or weight of machine; that the air cushions work instantaneously with softness and ease of movement; that there is an entire absence of vibration, as no metal springs intervene between the axle and the car body; that there is almost perfect balance in rounding curves; and that there is as nearly perfect working safety as can be secured. The machine has been undergoing severe tests for several months, having already run more than 4,300 miles over unfavorable roads, and is said to have given great satisfaction. Within the past few days it has made a speed of 40 miles per hour over an unusually rough road with great ease of movement.—*Consular Reports.*

THE JAPANESE LOYALTY AND THE MIKADO

BY W. L. SAUNDERS.

The death of the Emperor of Japan has excited a great deal of interest. Those who have visited the country and have studied conditions on the ground cannot but realize that Japan and the Japanese people are very much misunderstood. This is partly the fault of the Japanese themselves, who are not frank in giving information and who confuse questions relating to their government and people by statements that are at variance with each other.

During a recent visit to Japan I had an opportunity to get at the truth of many things from a distinguished Viscount, a professor at Tokyo University. It was from him that I learned that reliable Japanese history does not extend over a period of more than 600 or 800 years, notwithstanding the fact that even in the schools a history beyond that period is taught and believed by the common people.

The Japanese are exceedingly proud and jealous concerning all things relating to their country and people. No matter what he may think one can never get a Japanese to talk against his country or to criticise it in any way. There are, of course, intelligent and educated people in Japan who will frankly admit certain shortcomings, and who in answer to your questions will tell you the truth, but as a whole the Japanese people zealously guard the secrets of their country. This is to a certain extent commendable, because it is an exhibition of the intense loyalty of the people. They are loyal to their Sovereign, more loyal in fact than any other people on the face of the globe to-day. They are loyal to their ancestors, to their friends and to their country. Surely this spirit of loyalty is one of the highest of the virtues.

The Emperor is the embodiment of all that is great and good in the country. The whole history of modern Japan is written in the life of the Emperor who has recently passed away His reign of about forty-five years covers most of the period of modern Japan and it covers all the period of the actual Imperial reign, which was destroyed several hundred years ago when the Shôguns or generals came into power. In other countries revolutions usually affected the dynasty. The ruler was a party to or a victim of these upheavals, and dynasties were changed, kings were beheaded and governments upset. Not so with Japan. No revolutionist dared attack the Emperor. He was at all times the supreme power, and when, through the rise of powerful families, the control of the country passed to the Shoguns the Emperor, though retired and held in a glass case, was nevertheless respected and to him each Shogun paid tribute.

About forty-five years ago this condition of feudalism was destroyed by the abdication of the Shogunite and the restoration of the Emperor to power. This was the direct result of the opening of the door of civilization which had been going on for some fifteen years prior to the restoration.

It is unprecedented in the history of the world that a country should rise out of the depths of obscurity to become a progressive nation and a first-class power all in half a century, yet this is the history of Japan.

The present Emperor is a direct descendant of the first Emperor, though history is not clear as to who the first Emperor was. When the Chinese came over to Japan and introduced their Oriental civilization there, the Japanese found that the Chinese history dated back some two thousand years. This affected their pride to such an extent that they built up their own history as far back, at least, as that of the Chinese, and while much of this history must be taken as a romance yet no one doubts that the Imperial dynasty has remained unchanged.

It is a common mistake to say that the Japanese people look upon their Emperor as a god. There is little or no religion among the intelligent Japanese people. The old Shinto religion is confined mainly to the ignorant, and so is Buddhism. The educated Japanese may bow down to both the Shinto and the Buddha god, but he does not believe in either. He knows nothing about it, he sees no harm in it, it costs nothing, and so he accepts it; but he has no real, conscientious religious sentiment.

The true religion of Japan is loyalty, and this is symbolized in loyalty to the Sovereign. The war with Russia was an example of the practical working of this spirit of loyalty. Concentrate all the people on one idea and let that be devotion to the Emperor, which means, of course, patriotism, and it is difficult to withstand the onslaught. Japanese loyalty creates not only enthusiasm but concentration of effort, determination and bravery itself. So long as this spirit exists, and so long as the financial resources of Japan are maintained, it will be difficult for any nation to conquer these people.

From a little magazine published in Japan called "The Musashino" I have extracted the following sentiments contained in an article written by Tae-Kichi Yahe, entitled "Our Sovereign:"

"Of Divine descent and mountaing a holy Throne that has never been marred by a tread of unhallowed foot, our Sovereign is the focus of our loftiest reverence and profoundest awe. Reigning, by virtue of the noble Heritage, over the Empire from the misty past in unbroken succession, he is the center of our most zealous devotion and highest regard. His exalted Person is absolutely inviolable, his peerless Grace completely immune, and his elevated State wholly inalienable. We are bound to him by a bond of traditions that we cherish most and are intent to preserve.

"An exaltation felt at the apprenhension of one's heritage imparts a moral force that weighs down one's temperament for the building up of his character. A proper sense of personal dignity, worthiness and responsibility, promoted from the remembrance of one's ancestry, gives rise to a lofty sentiment that uplifts one's spiritual constitution and fits him for the straight, upright walk of life.

"The remembrance of the past, the memory of the predecessors and the respect for the dead that peculiarly characterize the mind of the serious-minded people are a source of their unconquerable self-respect. They esteem their lineage and cherish the records of their progenitors, drawing thus ever fresh draught for their pride to thrive. Every cult exults at its sainted predecessors, and every family takes pride of its deified ancestors.

"To our Sovereign we owe a debt of gratitude that is 'deeper than the depth of an ocean and higher than the peak of a mountain.' He justly deserves our sincerest regard, our most genuine loyalty and our truest devotion. Our allegiance to him is eternal and absolute. We are glad to sacrifice our bodies, souls and all in defence of his Person, his dignity and his State. We are ready to die for preservation of his Heritage. The holy dominion over which he rules, and shall rule for ages to come, has been inherited; and not an inch of it shall be alienated while our eyes are open and the warm blood flows in our veins. One who dares to touch our Imperial is 'a foe with whom we shall not share abode under the same heavens.' An indignity or contempt that our Sovereign may have suffered would never have remained without a speedy reparation by his loyal subjects.

"It is upon these senses of obligation and feeling of gratitude that the mighty structure of the Japanese patriotism and loyalty is built, that the lofty virtue of fidelity and mutual love and the exalted sense of honor of the people rest."

RAINFALL, EVAPORATION AND DRAINAGE

Mr. George A. Lindsay, in the Transactions of the Academy of Science, St. Louis, gives in novel and striking form some interesting statistics of annual rainfall. The rainfall of the State of Missouri in a single year was 43.9 cubic miles. In the same year 1,296.4 cubic miles of water is computed to have fallen over the whole area of the United States. These figures are tolerably comprehensible, but when we are told that the latter figures represent 6,000,000,000,000 tons of water then we are at sea again. As an illustration of the fact that most of the water that falls as rain never reaches the sea through the medium of drainage, but is evaporated from the land, Mr. Lindsay shows that the discharge of the Mississippi River at St. Louis is but little greater than the volume of rainfall over the State of Missouri alone, despite the enormous area drained by the river above that point.

TO AVOID TIRE PUNCTURES

Basing his theory on the principle that the carriage must be suspended upon air, Count Lieut. Soliani of Italy asserts that he has discovered a method by which pneumatic tires may be protected against puncture. His method divides the present pneumatic tire into three small ones placed inside the wheel so as to be protected by the rim, which is of strong, unpuncturable material. The three pneumatics act exactly as do those now in use, suffer neither from heat nor puncturing, and wear indefinitely. The Italian military authorities have examined the new method and declare it perfect, and just as speedy and comfortable as the old.

A NOVEL WAY OF TEACHING ROCK DRILLING

BY E. L. YOUNG.*

The mining department of the University of Missouri has developed methods and equipment for demonstrating in the class room and in the laboratory a number of important points in the practice of rock drilling and blasting, particularly as applied to drifting and tunneling.

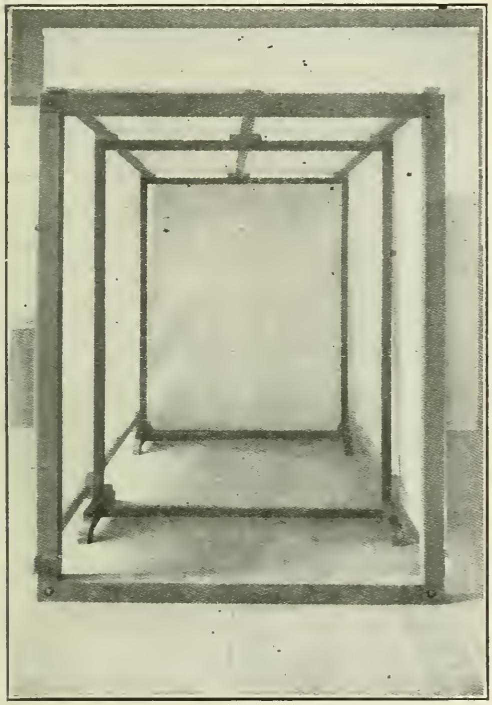

FIG. 1. THE APPARATUS.

Almost everyone who has attempted to teach rock drilling and blasting has been handicapped by the difficulty of instructing a large class of students in drifts and tunnels where only a few students can hear and see the instructor; by the difficulty underground of making students realize just where the holes are bottomed; by the difficulty of getting the student to realize exactly where the charge of powder goes; and by the impossibility of actually showing underground anything more than the drilled face of the drift before the charge is ignited, and the broken rock or the missed hole after the blast. Instructors have wished that they could show the bottom of each hole. It has seemed impossible to illustrate graphically the actual position of the several charges of dynamite and to demonstrate the distribution of the powder through the rock to be broken in tunnelling and drifting.

The equipment described in this article was designed primarily with the idea of inducing the student to think (in this exercise at least) of the bottom of the drill hole, of the actual volume of the rock to be broken by the powder, and of the new face of the drift rather than—as the student generally thinks—of the face of rock exposed, of certain customary set-ups of the drill, and of holes drilled according to custom. The idea has been to make the student think for himself and to give him an opportunity to see what can be done from certain set-ups of the rock drill.

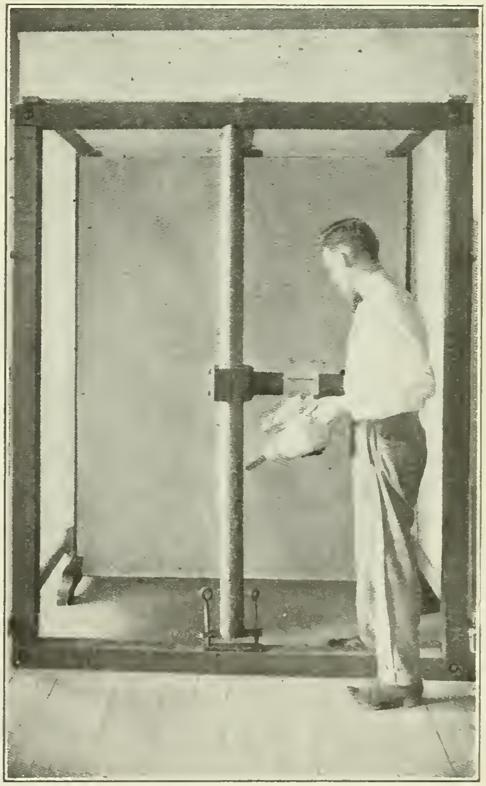

FIG. 2. DRILL SET-UP.

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*Director, School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

HOLES REPRESENTED BY TIN TUBES.

The equipment consists essentially of the following: (1) Light-weight, full-size columns, bars, arms, and rock drills made of wood. Light-weight apparatus is used in order to save time and to make it possible for one man to demonstrate rapidly the various points under discussion. The rock drill is used only to show the position of the drill steel relative to the arm and the columns and the length of the feed. (2) Telescopic tin tubes are used to represent the holes drilled. The tubes are made in 2-ft. lengths of various diameters, as 1¼, 1⅜, 1½, 1⅝ in., etc., to represent the portion of the holes drilled with steel of a given gage. (3) Colored oilcloth is wrapped about the tin tubes, to indicate the position of the dynamite in the hole. Rubber bands are used to hold the oilcloth in place on the tin tubes. (4) A portable, light weight, 4-piece timber set, 5x7-ft. in the clear, is used to support the column or the bar. This is not intended to represent mine timber. (5) Portable screens are placed parallel to the 4-piece set. The purpose of the screens is to support the tin tubes when placed in position to represent the holes drilled. A sheet of paper is stretched over the screen near the 4-piece set and indicates the position of the face of the drift. The other screen is placed in position to indicate the face to which the drift

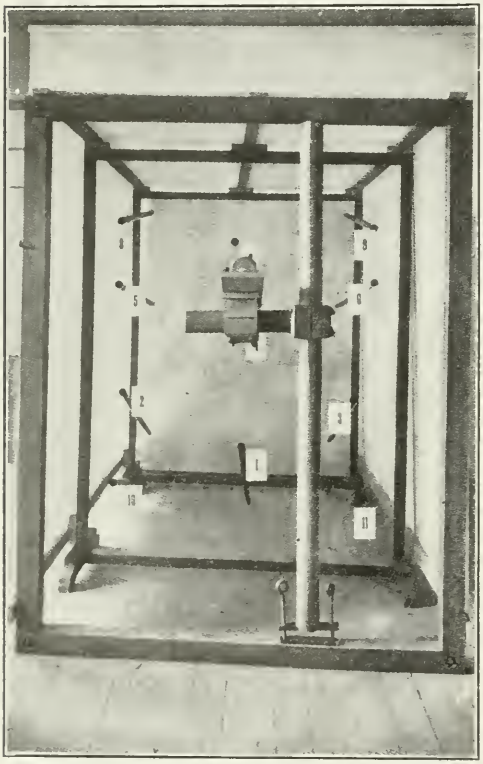


FIG. 3. TUBES IN PLACE.

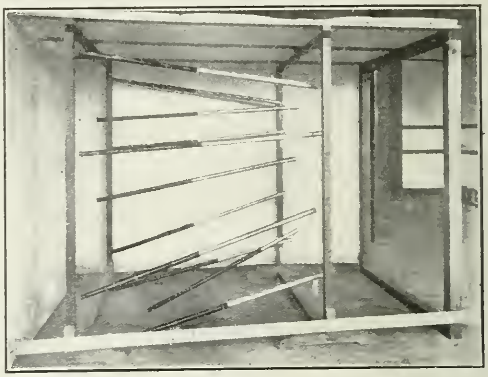


FIG. 4. SIDE VIEW OF FIG. 3.

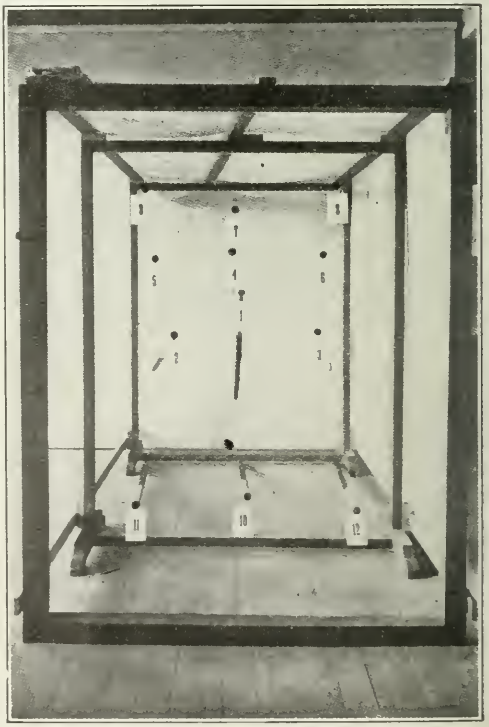


FIG. 5. TUBES TO SHOW ROUND OF HOLES AT LEONARD MINE, BUTTE.

will be advanced after the round of holes has been fired. The hook on the bottom of each tin tube representing a drill hole is hooked on the screen representing the face to be won, and the other end of the tube is supported by the rear screen. (6) Five 1x3-in. wooden strips are used as braces for the screens and the 4-piece set, and to support the canvas covering. (7) A canvas covering represents the walls and back of the drift. There are suitable eyelets for attaching the canvas to the wooden strips. This canvas covering is generally not required as most of the students conceive the position of the walls and back without this actual inclosure. (8) Cardboard letters and numbers are used for labeling drill holes. These indicate the order of drilling, the set-up from which the hole is drilled, and the order of firing. (9) Wires are used to support the tin tubes which may be required to indicate the position of short cut-holes.

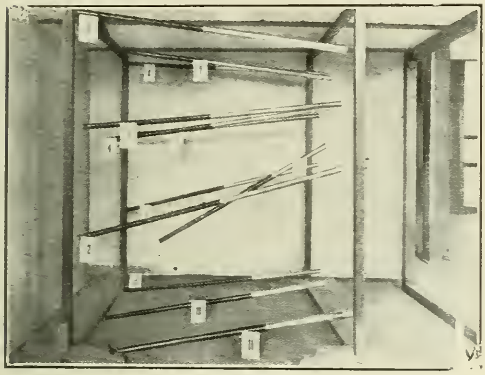


FIG. 6. SIDE VIEW OF FIG. 5.

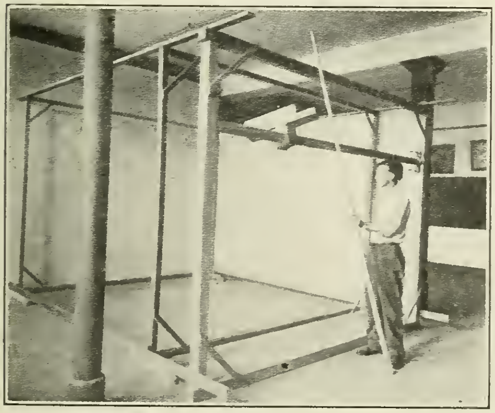


FIG. 7. TO SHOW TUNNEL, 8 BY 10 FT.

USE OF EQUIPMENT.

The use of this equipment may be illustrated as follows: A student is asked to demonstrate a set-up of a rock drill in a 5x7-ft. tunnel, and to show how the holes are placed. The equipment is placed at the beginning of the demonstration as shown in Fig. 1. Having explained where he expects to bottom each hole of the round necessary to break ground, the student shows (see Fig. 2) the first set-up and indicates where the second set-up will be, if more than one set-up is necessary.

The front screen is then covered with paper in order that the student may not have an opportunity to see more than he would if actually drilling into a face of rock. He then points each hole from the set-up, placing and hanging on the wire screens the several tin tubes necessary to show each hole drilled. He must show actually the size of hole he would drill, the necessary changes of gage of the drill bits, the angle of the hole, and the amount of powder charged. As designated by the student, one tin tube is put in place for each hole of the round. The student is not permitted to change any hole after it is bottomed. If more than one set-up is necessary, the work is carried on for the remaining set-ups in the same manner as for the first until each hole of the round is shown.

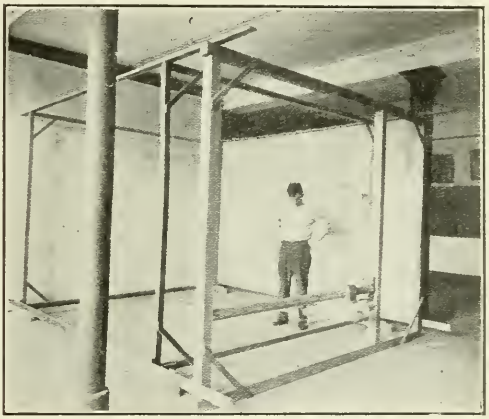


FIG. 8. STUDENT DETERMINING HEIGHT FOR BAR.

After the round has been placed, the paper is taken down then the student can examine and criticize his work (see Fig. 3). The instructor points out, among other things, the following: (a) The total footage of holes the student has used for the round. (b) The

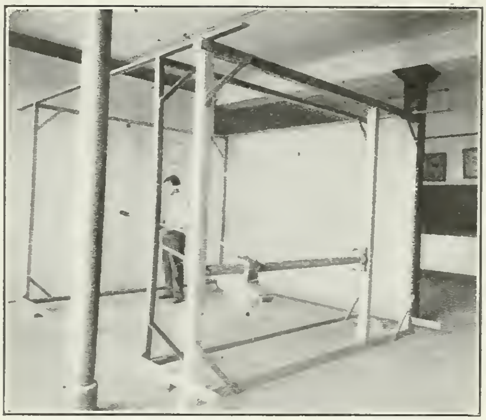


FIG. 9. STUDYING POSITION OF CUT HOLES.

holes that are unnecessarily long. (c) The danger of shooting the collar and primer off certain holes, providing the primer is put in last. (d) Any improvement possible in the angle of the holes, that is, where uppers might have been drilled to advantage instead of down holes or *vice versa.* (e) The position that would have made a more effective set-up. (f) Any improvement possible in the proportioning of the burden on each hole.

The student is reminded in each demonstration of the desirability of breaking the rock to a suitable size for shoveling; of the importance of having the "muck" thrown back from the face; of the importance of having the holes square the drift for the next round; and of the importance of placing the dynamite so that there may be no undue shattering of the walls and of the back.

It is not intended that this should in any way reduce the necessity for or the importance of demonstration and work with rock drills in a mine, but it has been found that many points may be made clearer by the use of this supplementary equipment. Moreover, the fact that there are "slips" and joints in rock has not been forgotten and that a set-up will depend largely on the way the last round broke. If the equipment and method described does nothing more than train the student to think of the burden he is putting on each hole, it will have accomplished much. These demonstrations have been of benefit to many who have had large experience in tunneling and drifting in hard rock.

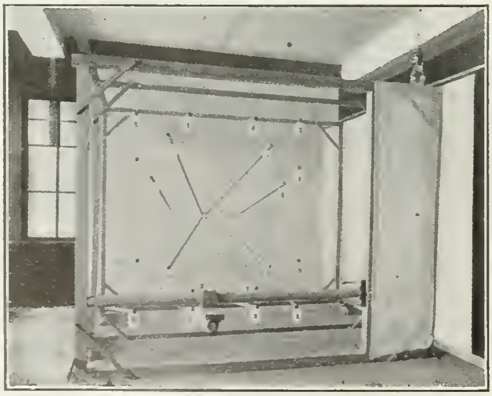


FIG. 10. ROUND OF HOLES TO SHOW LEYNER CUT.

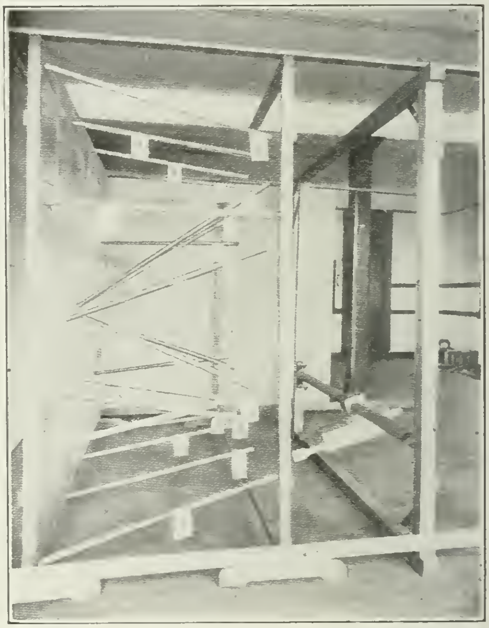


FIG. 11. SIDE VIEW OF FIG. 10.

Larger screens and other equipment are now being prepared in order to demonstrate graphically the pointing and loading of holes, and order of firing in tunnels of large cross section, such as the Roosevelt and the Laramie.

No other gas is known which has the wide explosive limits of acetylene. Any mixture of air and acetylene containing between 3 per cent. and 8 per cent. of acetylene is explosive. Explosive mixtures are thus readily formed in pipes and also in the external neighborhood of leaky joints.

EXPLOSIONS OF CARBONACEOUS DUST

The investigations which have been and are being carried out in nearly all mining countries into the explosibility of coal dust have convinced most people that this particular class of carbonaceous matter is even more dangerous than accumulations of fire-damp. But it is not only in the mine that disaster from this cause lies latent. It cannot be too clearly understood that wherever carbonaceous dust is produced, no matter from what source it arises, there is more than the possibility that sooner or later all the conditions requisite for the development of an explosion may simultaneously arise. The disastrous accidents which occurred at Messrs. Primrose's provender mill at Glasgow on the 10th of November last year, and at Messrs. Bibby's oil-cake mill at Liverpool a fortnight later fully illustrate our remarks.

Where the Glasgow explosion occurred, China beans, after washing and drying were crushed and broken between chilled cast iron plates and then ground between stones. The inspector has come to the conclusion that it was on the floor devoted to the latter millstones that the explosion originated. That it was a dust explosion there seems to be no room to doubt. A sample of dust collected from one of the beams in the mill was examined as to its explosive qualities. It was found to be ignitable at a temperature of 1050 deg. Cent., which is lower than the ignition point of many coal dusts. Further, the flame travelled appreciably faster through the bean dust than through most samples of coal dust tested in a similar manner. Mr. Smith is of the opinion that the disaster arose from the fall of some dust from an overhead beam into the naked flame of a gas jet used for lighting purposes, and that the propagation of the explosion is to be attributed to the disturbance of fresh dust by the initial explosion.

In the disaster at Liverpool there is every reason to suppose that the explosion started in a cellar containing a number of disintegrators employed for grinding oil-cake, locust beans, and other material. It is practically certain that the driving belt of a disintegrator broke and threw up a cloud of dust from the accumulation on the beams and machinery. How this cloud was ignited is less clear. There were no lighted gas jets in the neighborhood of the cellar at the time of the disaster, and on the whole the cause of ignition must be left an open question. Three plausible theories, however, have been advanced. It is possible that when the belt broke a workman may, in the darkened state of the room, have struck a match. Subsequent experiment showed that a cloud of the dust could be fired by an ordinary match when ignited in the cloud. In the second place, it is pointed out that the disintegrators were each provided with an electro-magnetic device for removing particles of iron from the feed. The wires of the magnets of one machine were found after the explosion to be broken and fused at the loose ends, and it is thus possible that the ignition of the dust was caused by a spark from these wires. Here, again, experimental confirmation can be produced, but the sequence of the breaking first of the belt and then of the magnet wires is not readily explainable. The third theory is based on the fact that a fuse wire near the broken belt, and forming part of the electric lighting circuit was subsequently found to have blown. In addition, a 16-candle power carbon incandescent lamp on the same circuit as the blown fuse was found to be broken after the explosion. This lamp is known to have been in use shortly before the disaster occurred. It is therefore, regarded as possible that the lamp broke coincidently with the belt, that "arcing over" took place, and that the fuse was in consequence blown.

The primary point to remember is this, that wherever carbonaceous dust of practically any kind is produced in any quantity conditions of safety should be enforced as rigorously as they are in a modern coal mine. This at once stamps the use of a naked flame for any purpose in such situations almost as criminal. If artificial light be required, incandescent electric lamps alone should be used. Particles of iron or steel in the material being ground should be removed by efficient electro-magnetic separators. Finally, every precaution should be taken against the escape of dust into the atmosphere, and if this, as is almost certain, cannot be completely avoided, thorough cleansing of all machines, elevators, conveyors, and wherever dust is liable to accumulate, should be carried out daily and preferably by suction methods.—From *The Engineer*, London.—(Condensed).

COMPRESSED AIR TUNNEL DRIVING IN WET EARTH

Compressed air for tunneling through wet earth, without the use of a shield, was resorted to in completing the Eastview tunnel, a portion of the 127-mile aqueduct and delivery system which will supply water from the Catskill Mountains to New York City. The work is unique in that it is the only section of the Catskill project where compressed air has been used in a tunnel, although the upper portions of certain shafts on other parts of the line have been carried through water-bearing material overlying ledge-rock by means of pneumatic caissons.

In the Eastview tunnel, slightly more than a mile in length, water-bearing earth was encountered for a stretch of about 800 ft. near the center, after headings had been driven through solid ledge from two portals and an intermediate shaft. This condition was known in advance as the result of the exploratory borings, and provision was made in the contract for the use of compressed air should the ground developed require it. When repeated efforts to advance the tunnel through the soft material without air proved unsuccessful it was decided to change the scheme of construction from open air to compressed air work. Bulkheads and locks were installed, a compressor plant set up and pressure applied for the first time on Jan. 26, 1911, the initial pressure being 10 lb., gage. Since that time the work has been carried on continuously under air, the pressure varying from about 10 lb. to 26 lb.

The excavation in compressed air was carried on from one heading only (north from the shaft, called the south lock) in three stages according to the wall-plate drift scheme. The first operation consisted in driving two small side drifts in advance of the heading proper, one on either side of the section. These two preliminary drifts were made just large enough for a man to work in, and in them the wall-plates, in 20-ft. lengths, were set to line and grade. When the wall-plates had been placed the second step in the excavation was begun, namely, the removal of earth from the heading proper. After an advance of a foot or so had been made a set of timbers was immediately placed to support the roof. The third operation consisted in removing the material from the bench. Side trenches, about 3 ft. wide, were excavated a few feet in advance of the main bench and 12 x 12-in. plumb-posts were set to support the wall-plates. After these had been set the remainder of the bench was removed and the operation repeated until there was room to place another set of timbers. Later grout, in the proportions of 1 part cement to 2 parts sand, was forced back of the timber for 400 ft. in the worst ground to fill any voids.

On account of the character of the wet earth there was a tendency for the material to flow upward through the bottom of the tunnel in the softest ground, and solid 12 x 12-in. invert timbering, covering a stretch of 300 ft., was placed sloping downward toward the center from each side so as to form a flat V and afford some degree of arch action. The joints in the segmental arch timbering were made secure by wooden cleats, 2 in. thick, spiked to the side of the timbers in each ring. These cleats, of course, left a 2-in. space between the main bents which was filled in with 2-in. planks so that the entire section was boxed in solid on sides, floor and roof.

It was found necessary, in order to hold the section to the desired shape, to supplement the permanent timbering by temporary timbering. This scheme of internal bracing reduced to a minimum the possibility of collapse from external pressure and held the section approximately to its true shape until concreting could be started. The key-blocks in the arch segment were set 12 in. higher than the extrados of the finished concrete arch to allow for settlement.

The average progress in excavating and timbering in the compressed-air section was 25 ft. per week in the one heading. Conditions similar to those encountered in the Eastview tunnel were reported in the driving of the Croton aqueduct, 25 years ago. The Croton line is located about 2 miles west of the Catskill line and was carried through soft water-bearing material without the use of compressed air. The English system of crown-bar timbering was used and in his book entitled "The Water Supply cf New York City," Mr. Edward Wegmann reports an average progress of 1.4 ft per week. The contractors on the Eastview tunnel are convinced that the compressed air methods they have employed show marked advantages over the earlier open-air scheme used in driving the Croton aqueduct in tunnel. It was noted at Eastview that when the air was applied it drove the ground-water back out of the sandy clay, so that the latter stood up well and caused no appreciable trouble during the work of excavating.

When the air was first applied an attempt was made to remove the material by hydraulic jetting, but the attempt was unsuccessful, for the material proved to be too hard to handle in this way after the water had been driven from it by the air pressure. In fact dynamite was generally used to loosen the heading and bench material.

The mucking was done with picks and shovels and the material loaded into low, narrow tunnel cars, designed especially to pass through an air-lock.

In the compressed-air section, a cable and an electrically-operated drum hauled the loaded cars from the heading and up a slight incline to the lock. The empty cars were coasted and pushed by hand on the return trip. From the south lock to the shaft and from the north lock to the north portal the muck cars were hauled by an electric trolley car which received current from an overhead wire.

THE AIR LOCKS.

There are two air locks, one in the north and one in the south bulkhead walls. These are each 20 ft. long and 6 ft. in diameter. On account of the unusually large amount of timber to be taken into the tunnel a special timber lock was built, thereby leaving the regular locks clear for the passage of the muck and concrete cars. The timber lock is simply an 18-in. cast iron pipe, about 32 ft. long, extending through the concrete bulkhead to the left of the main lock.

In addition to the tunnel locks there is a hospital lock at the construction camp, equipped in the usual way for receiving workers afflicted with the bends. There has been little occasion to use a hospital lock, however, for the maximum pressure in driving, 26 lb. per square inch, and in lining, 21 lb. per square inch (this was the maximum pressure up to May 1), has not been high enough to cause any appreciable amount of sickness. The men work an eight-hour shift under air pressure and there are three shifts per 24 hours, the length of each shift being limited by the New York State labor law.

COMPRESSED AIR PLANT.

The plant equipment for the compressed air work consists of an Ingersoll-Rand low-pressure compressor with a capacity of 1800 cu. ft. of free air per minute. This machine is run by a 50-hp. General Electric motor, operated on current purchased from the Westchester Lighting Company. There is also an auxiliary high-pressure compressor of 2400 cu. ft. per min. capacity, driven by a 100-hp. motor. This machine is located at the main power plant and was used for supplying air under high pressure to the drills in the rock section of the tunnel. The electricity is supplied at 13,000 volts and stepped down by transformers to suitable voltages for use in the motors.

PLACING CONCRETE LINING.

The placing of the concrete lining in the compressed-air tunnel was begun on March 11, 1912. Air pressure has been maintained in the tunnel at from 18 to 21 lb. per square inch while the concreting was in progress.

The scheme of delivering the concrete to the forms involves the use of nine tunnel cars which are run upon a regular schedule so that three cars are always being unloaded at the form while three are being filled at the mixer and the remaining three are on their way either to or from the tunnel. The haulage is done by a narrow-gauge electric trolley car and the distance from the mixer to the air-lock is about 2300 ft. The cars are dumped onto the working platform from which the concrete is shoveled into the forms; when the cars are run through the locks the sudden application of air pressure tends to pack the concrete down, making the cleaning of the bottom of the cars troublesome.

The practice in concreting the north and south bends of the tunnel, where compressed air was not used, was to run the concrete cars up an incline on to a platform within the forms and near their tops and discharge the concrete directly into place. In the compressed air section, however, this scheme could not be carried out on account of the large amount of temporary timbering which obstructed the bore and made the use of an incline impossible. As a substitute means of carrying the concrete to the top of the forms an electrically-operated elevator was used. Vertical guides were bolted to the ends of the forms and cages were put in to receive the cars from the narrow-gauge track through the tunnel and raise them to the concreting platform in the form. This elevator is an integral part of the form and requires no resetting when the forms are struck and moved forward into a new position.—Abstract from *Engineering Record.*

DEVICES OF VARIOUS PNEUMATIC INTEREST

Upon the oppoite page are assembled a number of sketches, taken from various contemporary sources, of pneumatic apparatus, or devices with which the air has something to do, which will doubtless be of interest to many of our readers.

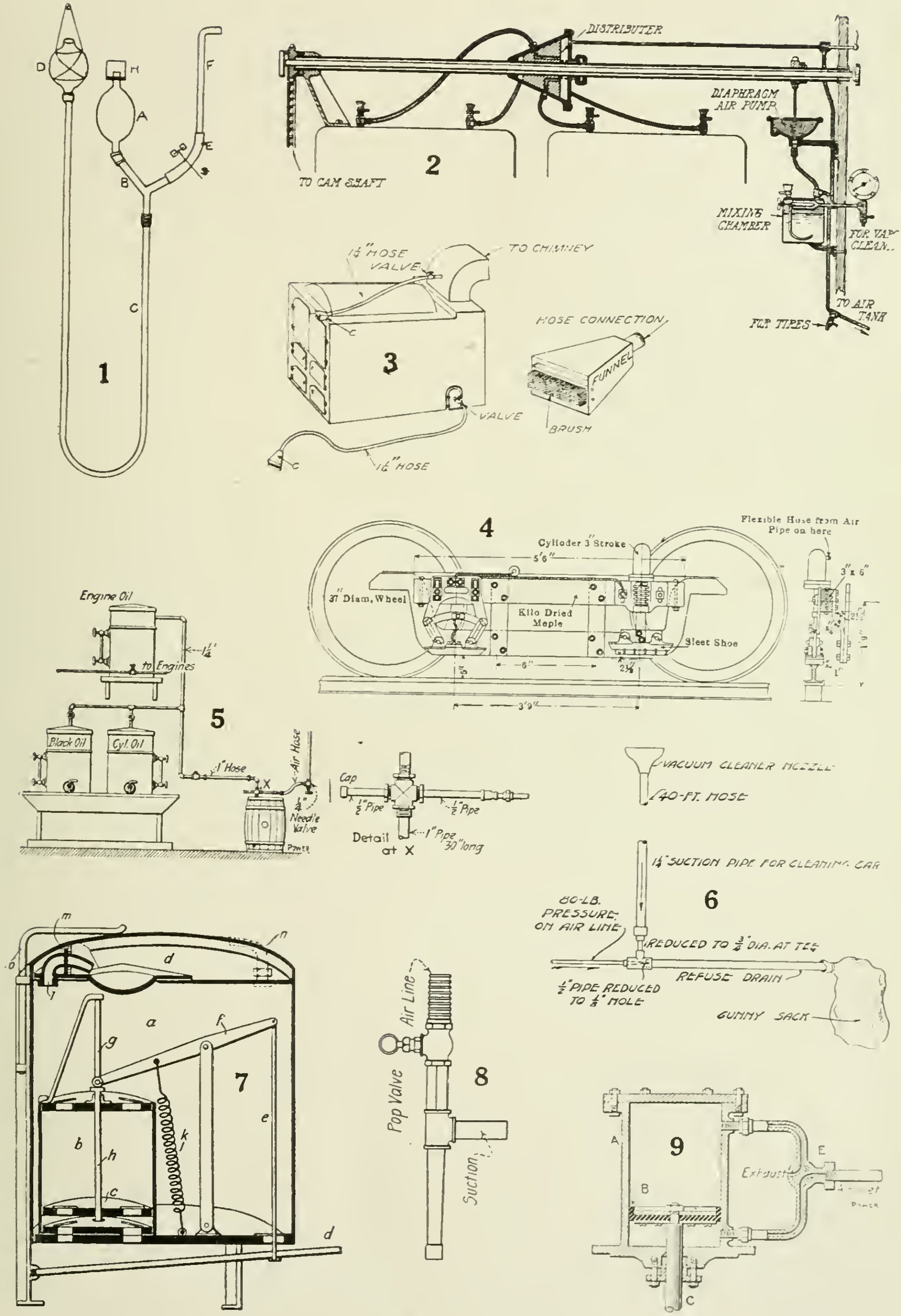
A SIMPLE LABORATORY VACUUM PUMP.

No. 1 is from the *Model Engineer,* London. For all ordinary purposes, it is said, where a perfect vacuum is not required, the pump shown, simple in construction and action, will be found to answer well.

A glass bulb or large pipette, A, is connected by means of rubber tubing, with a small glass Y piece, B, to the lower limb of which is affixed a piece of thick-walled indiarubber tubing, C (known as pressure tube by chemical dealers, or acetylene gas tube by dealers in rubber goods). This, in turn, is connected with the mercury reservoir D, which may be another bulb tube, as figured, or merely a plain glass funnel. The former is preferable, as there is less chance of the mercury being spilt. The reservoir is contained in a cradle of bent wire with a loop at the top for suspension. In the selection of the bulb regard should be had to the quantity of mercury available. A 4-oz. pipette holds 54 ozs. of mercury, or allowing for the tubes, about 5½ lbs. would be required. But whatever the dimensions of the reservoir and pump-head (as the bulb A is technically known), the length of the rubber tube C remains the same, and should be 45 ins., excluding the portions lapped over the glass at either end. Communication with the receiver, or vessel to be exhausted, is made by means of the left-hand branch of the Y tube to which is fixed a short piece of pressure tube, E, connected at the other end with a piece of glass tube, F, bent at right angles. A simple substitute for a glass tap which has the advantage of not being liable to leak is shown at G. It consists of a piece of wood pivoted at one end and pulled downward toward the baseboard at the other end by a short indiarubber ring. If the pressure is properly adjusted by using a strong enough ring, the tube E will be kept closed, except when the free end of the lever is lifted for a moment while working the pump. It only remains to fit a valve, H, at the top of the pump-head. The several parts of the pump may be clamped to a stout pine board of suitable size, each part being supported on a small block of wood. The pump head will require a small bracket with a hole cut to take the curvature of the glass. It will be as well to make this a little on the large size and line it with soft leather or thick cloth. The other parts can be fixed with saddles made by bending a strip of brass in the middle and drilling holes in the ends. All joins between glass and indiarubber should be made by heating the glass till it just melts the rubber and pushing the latter on for about three-quarters of an inch. This makes a very firm joint, and dispenses with the necessity of binding on with wire, except at either end of the long rubber tube, where the joins are subjected to considerable strain. The reservoir being filled with mercury, it is raised until the metal flows up to the top of a pump head, the position being marked on the board and a stout hook screwed in to hold the reservoir on future occasions. It is then lowered until the mercury has fallen below the branch in the Y tube, leaving a torricellian vacuum above. Another hook may be screwed into the base to hold the reservoir in this position. The lever G should be raised for a second before raising the mercury again in order to allow the air to escape from the receiver into the pump head.

THE BAUM AUTO-STARTER.

No. 2 shows an apparatus made by the Baum Brass and Model Works, Minneapolis. Compressed air operates it, the air being compressed by a diaphragm pump which has no piston and is operated by means of an eccentric from a hollow shaft, chain-and-sprocket driven from the cam-shaft. On this shaft is mounted a distributor, with leads to the pet-cocks of the cylinders. The air line is provided with a pressure-gauge, and leads to a conveniently located storage tank. A small knob on the dash is connected through the starter shaft, which is hollow, to a pin clutch, which engages the loosely revolving driven



VARIOUS PNEUMATIC DEVICES.

sprocket. Air is admitted to the distributor through a supply valve, controlled by a small lever on the dash, the air first passing through a mixer, which consists of a small gasoline tank of 1 quart capacity, in which is an adjustable saturated wick. In operation, the clutch-knob of the starter is drawn back and the pump and handle is next turned, admitting the explosive vapor into the distributor and thence to the cylinders. When the engine is started, the supply valve is closed, and the pump allowed to continue pumping until a pressure of 100 pounds or more shows on the gauge, when a push on the clutch-knob stops the starter-shaft from rotating, the chain and sprocket running idle. Air for the tires is obtained by connecting a few yards of tubing to the stop-cock below the mixer, and a gasoline vapor for cleaning purposes is obtained by connecting the tubing to the stop-cock below the gauge.

A BOILER-ROOM VACUUM CLEANER.

A correspondent of the Practical Engineer sends sketch No. 3 which he calls a "natural" vacuum cleaner. He says take two old 1¼ in. gate valves and make a connection on the top of the boiler to the breeching as shown and get a light 1¼ in. hose long enough to reach the farthest dusty place on the boiler, connect the hose on the breeching and then put on the dust collector as shown at *C*. The little sketch at the right shows how to make the dust collector, only a funnel with a long-haired brush fixed in the end, with the hair extending from the end so as to sweep or loosen the dust.

PNEUMATIC SLEET SHOE.

No. 4, from the *Electric Railway Journal*, shows a pneumatically operated sleet cutting shoe designed by W. Silvers, superintendent of equipment of the Michigan United Railways.

Each car is equipped with two of the pneumatically operated shoes attached to the front end of the third-rail beams on the front truck. The sleet-cutting shoe is of the same design as the regular third-rail shoe, but has four steel cutters set diagonally in its face and cast integral with the body of the shoe. The sleet-cutting shoe is mounted on a vertical iron shaft which passes through guides and is attached to the piston of an air cylinder which has a 5-in. stroke. A spiral spring around this shaft holds the shoe off the rail except when air pressure is put on the cylinder to press the cutters against the rail. The air supply is taken from the train line through a ⅜-in. three-way valve and pipes extending under the car to a point convenient for connecting with the cylinder which operates the shoe. This connection between the pipes and the cylinder is made with a 2½-ft. length of ⅜-in. air hose, secured at each end with hose clamps. An ordinary straight valve is placed in each supply pipe to enable the motorman to use one or both shoes as occasion demands.

COMPRESSED AIR OIL LIFT.

No. 5, from *Power*, is a self explanatory sketch of an arrangement for transferring oil from barrels to engine room storage tanks. It is simple in construction and can be made in a short time (with the exception of a special bushing which requires lathe work) by any one familiar with pipe tools. An enlargement of detail at X is shown at the right. Care should be taken not to open the air valve too suddenly, especially when pumping cylinder oil, which is generally heavy and hard to move. It is best to let the cylinder oil stand in a warm place for a day or two before attempting to pump it out. A ¼-in. needle-valve on the air line should be used, but an ordinary valve will do if the attendant is careful.

HOME-MADE VACUUM CLEANING OUTFIT.

No. 6, from the Electric Traction Weekly, shows a vacuum cleaning outfit got up and in use in the shops of the Ohio Electric Railway, Lima, Ohio. The shops of the company are equipped with a compressed air system, the air being used for numerous shop purposes and for blowing out motors, controllers, etc. Each pit is equipped with an air line carrying 80 lbs. pressure. A ½-in. pipe from this air line is narrowed down to a nipple with a ⅛-in. hole in the end which is thrust into one end of a 1¼-in. tee, the other end of the tee being connected with a refuse drain pipe leading to an ordinary gunny sack. Into the side of the tee is a ¾-in. pipe connected to a 1¼-in. suction pipe consisting of 40 ft. of hose and terminating in a vacuum-cleaner nozzle. The force of the air through the ⅛-in. nipple creates a sufficient vacuum in the suction pipe to thoroughly clean all surfaces to which the vacuum-cleaner nozzle is applied. It is found that a man can get over a 55-ft. car and do a good job of cleaning in 20 minutes.

PORTABLE FORGE WITH PISTON BLOWER.

A portable forge, made in England, in which the blast is supplied by a cylinder with reciprocating piston, instead of fan or bellows, is shown by No. 7. The entire body of the forge is used as an air reservoir whick makes the blast quite even. There is an ordinary tuyere the blast of which is controlled by a sliding valve. One or more gas blow pipe nozzles can be affixed to the top of the forge, and these can be turned in any direction.

SAND BLAST DEVICE.

An inexpensive portable sand blast device for occasional sand blasting is shown, only the nozzle portion, in No. 8. The air hose connects with the air supply which, to give the best results, should have a pressure of 80 to 90 lb. The suction hose leads to the sand pile or bin nearest the work, the best plan being to have as short a suction as possible. It is made by the Niagara Device Company, Buffalo, N. Y.

PNEUMATIC VALVE LIFT.

No. 9, from *Power,* is only to be regarded as a suggestion by a correspondent. It is a device for operating large valves, consisting of a cylinder *A* bolted to the upper flange on the valve body; a piston *B*, fitted to the upper end of the valve stem *C*, which is packed, as shown and a four-way cock *E* connected by means of unions to the cylinder *A*. The illustration shows the position of the piston when taking air underneath and exhausting above the piston *B*.

LIQUEFIED NATURAL GAS

BY DR. WALTER O. SNELLING.

It has long been known that during cold weather a liquid collects in the exposed pipes at many natural gas wells. At first the matter was regarded solely as a nuisance, since drip tanks had to be installed to separate the liquid from the gas, and when a considerable quantity of the liquid accumulated in the tanks they had to be emptied.

That the liquid which thus collected in the drip tanks was gasoline was probably recognized by many persons, but for a period of several years there appears to have been no realization of the significance of the fact, and practically no attempt was made to utilize the product. After some years of this waste, the collection and utilization of the gasoline seems to have come to the mind, at about the same time, of several men in widely separated localities. In the Pittsburg district the Robinson brothers appear to have been the pioneers in this development, and they made arrangements with the lessees of a number of gas wells by which they were allowed to draw off the liquid from the drip tanks and dispose of it for a part of the profit realized.

The gasoline which was thus obtained was a perfectly transparent and colorless material of very satisfactory grade. With systematic efforts to collect this material came the observation that different sources of natural gas differed greatly in regard to the amount of gasoline which was produced and the conditions under which it would separate. Natural gas which came from the earth under high pressure would seldom give a liquid condensate, even in the coldest weather, while the very heavy gases, which come from oil wells and which are under very slight rock pressure, would frequently give an abundant supply of gasoline. But with the coming of summer, as the temperature out of doors became higher, even the amount of liquid which collected in the best wells became greatly lessened. It was to regain the profit which was thus found to be slipping away that the earliest efforts were made at compressing and cooling natural gas in the efforts to separate from it the gasoline which it holds in the form of vapor.

It was found possible to prepare gasoline of excellent quality by simply compressing the natural gas in an ordinary air compressor and then passing the compressed gas through cooling coils, connected to a suitable drip tank, from which the separated gas could be drawn off. From the heavy or "wet" natural gas of oil wells it is not uncommon to get six or seven gallons of gasoline from each 1,000 cu. ft. of gas treated, and there are many gas fields from which three to four gallons of gasoline per 1,000 cu. ft. of gas may be obtained. Even with compression and cooling it is not possible to produce gasoline from natural gas, which comes from the earth under high rock pressure, and this is naturally to be expected, since such gas consists almost entirely of methane, and the natural pressure which exists in the earth has been sufficient to prevent its carrying any considerable amount of the heavier hydrocarbons. At the present time the industry of producing gasoline from natural gas has assumed large proportions; some hundreds of plants are already in operation, and the aggregate production has reached many thousand gallons per day, most of which is sold as a blended product composed of a mixture of refinery naphtha and natural gas gasoline, this blended product giving excellent results for all purposes for which ordinary refinery gasoline is used.

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*A paper read before the Pittsburg Section of the American Chemical Society.

With the earliest attempts at utilizing the new gasoline, attention seems to have been called to the fact that it was in nature not identical with ordinary or refinery gasoline. Some natural gas gasoline contains dissolved gases to such an extent that when resting quietly in a glass vessel it effervesces or "boils" strongly, and gives off vapors so rapidly that the volume is greatly reduced by standing even for a period of an hour or so. That the vapors thus given off formed an explosive mixture with air was forcibly shown by a series of accidents which were associated with the early efforts in the use of natural gas gasoline. It was in the effort to find a means of separating from natural gas gasoline its dissolved gases that my first studies in connection with this subject were made.

Repeated efforts had been made to separate the dissolved gases by distillation. In many cases the gasoline produced at the compressor had been placed in steel vessels, heated by steam coils, and there warmed until a half or more of the gasoline had been evaporated. Even after this wasteful treatment the remaining gasoline was found to contain dissolved vapors to such an extent that it gave abnormal pressures when tested and gave off gases to such an extent as to be considered dangerous. Efforts were also made by some of the producers of natural gas gasoline to free their products from dissolved gases by exposing the material to the air in shallow tanks, and I understand that at one plant over 75 per cent. of the condensate produced was allowed to evaporate into the air in the effort to obtain a satisfactory product; but even in this extreme case the tendency of the vapors which escape to carry with them the heavier products, and the tendency of the heavier residue to still retain a portion of the dissolved gases, made this method not wholly successful, even after three gallons of condensate out of every four gallons produced had been allowed to go to waste in the air.

After considering the matter for some time it came to me as a happy inspiration to try to utilize the critical pressures of the different gases as a means for their separation. It is well known to physicists that there is for each gas a critical temperature, above which no amount of pressure, however great, will reduce it to a liquid condition. It seemed to me that by some suitable arrangement it ought to be possible to volatilize a mixture consisting of ethane, propane, butane, pentane and hexane, for example, and then under high pressure to introduce into such mixture a coil heated by means of superheated steam or hot water to such a temperature as to be above the critical temperature of ethane and propane, for example, but below the critical temperature of butane, hexane and pentane; and under these circumstances it seemed natural to suppose that the liquid which was separated by means of the coil would consist mainly of butane, pentane and hexane, and that the ethane and popane would be left as uncondensed gases, to be condensed as a subsequent operation. I carried out some experiments with this method and found it to be all that I had hoped. By means of a series of coils, heated to different temperatures intermediate between the critical temperatures of the different gases, I found it possible to fractionate the vapors from natural gas gasoline so as to obtain as one fraction gasoline equal in every respect to the best refinery gasoline, and this result was achieved without the loss of any of the original products.

The critical temperature of a gas is a physical constant and is not changed by pressure; and the selective condensation of vapors under very high pressure (up to 1,000 lbs. per square inch) upon hot coils in higher temperature than the critical temperature of part of the gases present promises to give important and valuable results not only in the preparation of liquid gas, but also in other refining operations. In its nature the new process of refining is entirely different from the ordinary method of fractionation by distillation.

The material which condenses upon the last coil in the series consists of ethane and propane, two gases which may be readily changed to the liquid condition by pressure and cooling, but whose boiling points under normal conditions of pressure are many degrees below 0 deg. Cent. That these gases, liquefied and contained in strong steel cylinders, would form an ideal illuminant, seemed evident, and I at once carried on further experiments to determine the possibility of so producing and utilizing them.

At about this time my attention was called to the work which was being done by Frank P. Peterson, of Grove City, Pa., and of C. L. Kerr, of Pittsburg, Pa. Both of these gentlemen were making efforts to harness the enormous supply of energy which was slipping away in the form of wasted natural gas. Mr. Peterson had made successful efforts to condense the lighter gases remaining after the separation of gasoline from natural gas, and to obtain a liquid product which he believed might be suitable for use as a substitute for Pintsch gas in the lighting of cars; and Mr. Kerr and his cousin, A. N. Kerr, had also carried out experiments along a somewhat similar line. We all realized that the problem, which we had each approached from a different angle, was capable of solution by the joint methods which had been worked out; and, making use of the liquid product produced through the stage-compression method of Mr. Peterson, I found it possible to effect, by the method which I already explained, a complete rectification of the material, thus obtaining a liquid gas which could at all times be produced of uniform quality and without the waste of any portion of the original gas.

The results which had been obtained are now so well known that it is not necessary for me to refer to them in detail. Tests made with great care have shown that it is possible to produce from natural gas, by a combination of the methods of stage compression and rectification, not only gasoline of the most excellent quality and equal in every respect to the best grades of refinery product, but in addition to recover all of the ethane, propane and butane, as a liquid gas, in such a form as to make it a convenient, safe, clean and cheap method of lighting isolated dwellings, such as country homes, seaside resorts, lighthouses and light buoys, etc.

For many years the waste of natural gas in the United States has reached enormous proportions. Dr. I. C. White, State Geologist of West Virginia, has in particular called attention many times to the enormous extent to which natural gas and oil well gas was being allowed to escape, with the consequent loss to the nation of the equivalent in heating power of many millions of tons of coal.

This waste no longer seems necessary, since it is these very gases from oil wells which have up to now been the most difficult to utilize in pipelines, etc., that are best adapted to the production of liquid gas and gasoline by the new methods. Plans are already under way to utilize some millions of cubic feet of gas daily in the production of gasoline and liquid gas, and thus to add decidedly to the national supply of both gasoline, a material which is finding each day ever-widening uses, and liquid gas, a product which seems destined to play a large part in the lighting of isolated dwellings.

The name "Gasol" has been given to the liquid gas produced by the new process. When under a pressure of 500 pounds to the square inch it exists as a clear, transparent liquid. When the pressure is lessened it changes into gas, and at normal or atmospheric pressure this gas is, unlike the gas produced by blowing air through gasoline, for example, extremely dry, and does not give any liquid condensate in the pipes, etc., all of the hydrocarbons which so condense having been separated in the process of rectification and going into the gasoline product. One volume of liquid Gasol produces about 250 volumes of gas upon release of pressure, and the gas so produced has a heating value of about 22,000 calories per liter, or about 2,400 B. t. u. per cubic foot. When it is remembered that the heating value of ordinary coal gas is only about 600 B. t. u. per cubic foot, and manufactured oil gas is less than 650 B. t. u. per cubic foot, it will be seen that the new gas has about four times the heat producing capacity, when equal volumes are considered, of either coal gas or manufactured oil gas. In addition, its flame temperature is much higher, being decidedly higher than the flame temperature of natural gas or any other of the common gases used for heating. The flame temperature of ordinary natural gas burning in air is about 2,150 deg., and the flame temperature of ethane burning in air is about 2,205 deg. The flame temperature of the new gas is about 2,300 deg., and since the amount of light produced from the Welsbach mantle bears an important relation to the temperature of the flame, the reason is here seen for the remarkable brilliancy of the light produced by the new gas, which excels in this respect all gases previously known.

It must be remembered that the preparation of liquid products from natural gas is itself not new, and liquid gas has been prepared for years from oil by destructive distillation, and also from coal and from natural gas. In connection with the preparation of a high-pressure liquid gas from natural gas, Frank P. Peterson has made important inventions, and C. L. Kerr, A. N. Kerr, T. G. Phinney and others have done very important pioneer work. The new process of preparing a liquid gas of perfectly homogeneous nature and uniform composition is the culmination of the work of many men, and of several years of experimenting. It opens to the use of the world the enormous volumes of oil well gas now so generally wasted, and produces from this waste material a product which gives to the country home all of the conveniences of gas for lighting and cooking, thus giving to the farm advantages which have been up to now available in general only to the city.

PHYSIOLOGICAL EFFECTS OF CO.*

An interesting pamphlet on carbon monoxide has recently been issued by the Bureau of Mines, in which attention is drawn to the dangerous properties of this gas and to the use of mice and birds for detecting its presence in mine air. The author quotes largely from various publications of Dr. J. S. Haldane of Oxford University, who for many years has made special study of the subject of mining hygiene and the dangerous gases met in mines. The author states (p. 6): "According to Haldane, carbon monoxide has no other effect than that resulting from its interference with the oxygen supplied to the tissues, and apart from its property of combining with the hæmoglobin it is physiologically indifferent, like nitrogen." The author also outlines an experiment in which he remained for twenty minutes in an atmosphere containing 0.25 per cent. of carbon monoxide, "at the end of which time he suffered only a slight headache, although later he became ill. The illness lasted for several hours and was accompanied by nausea and headache." The quotation from Haldane, and this experiment, are likely to give a false impression as to the dangerous properties of this gas; it has therefore seemed wise to give a few facts that others may not be led to repeat the experiment made by the author of the pamphlet, and to give some idea of the dangerous nature of this gas even when present in very small amount.

Carbon monoxide is a product of incomplete combustion. It is present in large quantities in producer gas and water gas, and in dangerous amounts in the gases from boilers and furnaces of all kinds. It is often present in large proportions, and always in dangerous amounts, in powder smoke, in the gases from underground as well as surface fires, and in the afterdamp from explosions of firedamp and coal dust.

CO MAKES HAEMOGLOBIN INERT AS AN OXYGEN CARRIER.

Carbon monoxide has the property of forming a compound with the hæmoglobin of the blood. The effect of this is to make the hæmoglobin, so combined, practically inert and to prevent it from acting as a carrier of oxygen. When so much carbon monoxide is absorbed that the greater part of the hæmoglobin is inert, death results. The affinity of carbon monoxide for hæmoglobin is more than 200 times greater than that of oxygen, so that when present in the air, even in small quantities, it is freely absorbed by the blood. Carbon monoxide is not displaced by oxygen but is dissociated by natural processes, and escapes in the expired air. Where large quantities are absorbed, it may be several days before the last traces disappear. According to Doctors Edsall, von Jaksch, Haldane, and other authorities, 0.05 per cent. of carbon monoxide is dangerous. According to Haldane, sever symptoms were observed from breathing air containing 0.02 per cent., or one part in 5000. With this small amount present the blood becomes 20 per cent. saturated after about 20 hr., producing slight giddiness and shortness of breath. At this point an equilibrium seems to be established, and the dissociation of the gas keeps pace with its absorption. With increasing percentages of carbon monoxide, the saturation of the blood becomes greater and the time required to produce the maximum effect shorter. With 0.08 per cent. present, the blood becomes 50 per cent. saturated within a few hours; it becomes scarcely possible to stand and even slight exertion results in loss of consciousness, the sense are confused and the judgment is impaired. Sometimes the victim either becomes stupid and drowsy, or much excitement results, not unlike the effects of alcohol. Another experiment by Doctor Haldane proved that with 0.20 per cent. CO in the air the blood becomes 50 per cent. saturated in 70 min. With 0.25 per cent., the amount present in the Bureau of Mines, experiment, this dangerous condition would be reached in less than one hour.

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*Professor Henry S. Munroe in School of Mines Quarterly.

CO PRODUCES CONGESTION IN THE VITAL ORGANS.

According to von Jaksch, the absorption of 0.8 gram of carbon monoxide is fatal. According to Haldane, if death occurs gradually the hæmoglobin is usually about 80 per cent. saturated with carbon monoxide. Post-mortem examinations of persons who have died from carbon monoxide poisoning show that the effect is to produce intense congestion of the vital organs, especially in the brain, usually accompanied by small hemorrhages. It is possible that this congestion is due to the attempt of nature to make good the diminished efficiency of the blood by supplying larger volumes at needed points.

Even when death does not occur, serious results are likely to follow from the absorption of this gas by the blood. The after effects are lesions, cysts and local softening of the brain tissue, inflammation of the membranes of the stomach and intestines, pneumonia, bronchitis, pleural effusions, inflammation of the kidneys, fatty changes in the heart, ænemia, splenic enlargement and other derangements of vital organs, sometimes resulting in death even after several years. It is believed that Sir Clement Le Neve Foster was a victim to carbon monoxide poisoning which occurred on a visit as chief inspector of mines to a mine in Cornwall a few years before his death. From the full record given by Mr. Foster of his symptoms while exposed to the gas underground it does not appear that there could have been more than 0.08 per cent. of carbon monoxide present, nor that his blood could have been more than 50 per cent. saturated, although direct evidence on both these points is lacking. The experiment made by the author of the paper recently issued by the Bureau of Mines, in which he exposed himself for 20 min. to an atmosphere containing five times as much carbon monoxide as is known to be dangerous, was therefore hazardous and even though the experimenter apparently suffered but little ill effect a somewhat longer exposure would certainly have resulted in serious injuries, the after effects of which might have proved fatal.

MINERS' PHTHISIS FROM CO POISONING.

One of the most serious dangers from the presence of carbon monoxide in the air of mines is the effect upon the health of workmen who are daily exposed to the breathing of small amounts of this gas. The blood, when partly saturated, is thereby rendered less able to perform its proper functions, so that the patient suffers from ænemia and all the complications that may result from this weakened condition. According to Doctor Edsall, the disease known as miner's phthisis has been shown to be due chiefly to carbon monoxide poisoning. Recent observations have shown that for some hours after a blast, under the conditions of ordinary mining, carbon monoxide may be present in the air in dangerous amounts, and undoubtedly the blood of men engaged in sinking, drifting, and stoping where the circulation of air is deficient is partially saturated with carbon monoxide the greater part of the time.

EFFECT OF CO IS CUMULATIVE.

By some authorities it is believed that the serious effects above outlined, due to absorption of carbon monoxide by the blood, are supplemented by direct toxic action on the nervous system, on the muscles, the heart and other organs. It is believed by others that there is a cumulative action and that those who have been poisoned by this gas are more likely to become victims when again exposed to it. It is quite certain that dissociation of carbon monoxide from the blood is slow and that those whose blood is partly saturated will sooner fall victims where larger quantities of the gas are breathed than those whose blood is free from this gas. Men who have repeatedly suffered from carbon monoxide poisoning become very sensitive to the gas, and in most instances are compelled to abandon work in which they are compelled to breathe air containing it.

MANIFESTATIONS OF CO POISONING

The symptoms by which carbon monoxide may be detected are not difficult of recognition. The blood becomes a brilliant cherry-red, and in serious cases red or bluish-red spots appear on the front of the neck, on the trunk, thighs and elsewhere, lasting for some days, and in fatal cases apparent after death. The mental disturbances, weakness and lassitude, have been noted. This is followed by headache, accompanied by nausea, often lasting 24 or 48 hr., even in slight cases. In more serious cases, headache may recur at intervals for some months. Loss of consciousness with convulsions, may occur several hours after the poisoning. One of the first symptoms is weakness in the knees and legs, sometimes lasting for days, with aching from the knees to the ankles. Local pains in the region of the heart, and palpitation of the heart, are common and may recur at intervals for a month or more. Foster, and several others, have published valuable notes on these symptoms, which will be found in the appendix of Foster and Haldane's "The Investigation of Mine Air."

HANDINESS OF COMPRESSED AIR

A writer in the Southern Engineer calls attention to the variety of compressed air employments in pumping stations. In one station, he says, there are no less than eight different applications of compressed air, while in other stations the number of uses is sometimes greater than this. The station referred to contains triple expansion crank and flywheel pumping engines. Compressed air is needed on the discharge side of these pumps as a cushion. Air is generally forced in by means of a small electrically driven compressor when starting the pumps. After starting it is sometimes found necessary to diminish the cushion, because of the air that is carried over with the water from the suction well. This air, under a pressure of 70 pounds, the pressure maintained in the water mains, is also used to close the exhaust poppet valves on the intermediate and low pressure cylinders, a sufficient amount of air being maintained in the air chambers of these pumps by self-contained air compressors.

The oiling system of this station is operated by compressed air taken from the air chambers. There are two galvanized tanks capable of standing the water pressure, each being of sufficient size to supply the station for about eight hours. One of the tanks is filled with oil, and air under 70 pounds pressure applied thus forcing the oil wherever needed. The return oil is led to a filter and from the filter it flows into the second tank. When the first tank is almost empty, air pressure is applied to the second or full one, and pressure taken off the one that is nearly empty.

Compressed air is used to pump water by means of an air lift from an artesian well into a large tank above the boilers. The compressor supplying air for the air lift also supplies air for pneumatic hammers, blowing out electric generators and for blowing the superheaters. Compressed air has also been used in place of the steam jet in conjunction with the Roney stokers.

In the water purification department compressed air is used in large tanks which store sufficient water to wash the filters. These tanks are strong enough to stand the full pressure of the large pumps and when empty contain about 16,000 cubic feet of air, which, when the tanks are filled, is compressed into a smaller tank above. The air is then used for agitating the iron and soda solutions required in the process of filtration and purification.

Wherever air is used it is evident that steam would not do as well if at all. For instance, the lift from the surface of the water in the artesian well is over 100 feet, and to install a pump capable of raising water from the well would be very costly, especially when compressed air is so conveniently at hand and obtained so cheaply. Steam also would not work as smoothly as air in the closing of the low pressure poppet valve.

EXTINGUISHING A FLAMING GAS WELL

There are various tricks resorted to for extinguishing blazing gas wells. A well at Lone Pine, Pa., with an 8 in. casing and a capacity of 5,000,000 cubic feet a day, was struck by lightning recently and the flame lighted the country for miles around, while the heat was so intense that operations near by were impossible. After three days a very simple device gave quick success. By the aid of long ropes a boiler stack, with a base mounted on rollers and guys to keep it upright, was moved over the well, the flame then raging at the top of the stack. A sudden jerking away of the stack made a break in the gas current and the flame went out instantly.

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EVERYTHING PNEUMATIC

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DON'T WORRY ABOUT THE ATMOSPHERE

Collective humanity, like the individual man, creates for itself—makes out of nothing—many unwarranted worries. Our supplies of coal and iron are going to give out, and what will we do then? Our earth-drawn nitrates for fertilizers are apparently much nearer exhaustion than coal and iron, and now that we turn directly to the atmosphere to abstract a supply a new worry is invented. What will we do when the air fails us?

It is proper to remember that we are not as big in comparison with the earth and its appurtenances as we are apt to think we are, and we have little power to disturb its established arrangements. We may say that—in very round numbers—the total weight of the atmosphere is 5,000,000,000,000,000 tons. That woud be—in the same style of numerical rotundity—3,850,000,000,000,000 tons of nitrogen and 1,150,000,000,000,000 tons of oxygen. Now, suppose that we abstracted a million tons, or a hundred million tons, of either how much would they be likely to be missed?

As a matter of fact we are mechanically abstracting from the atmosphere very small quantities, comparatively, of both nitrogen and oxygen, and these abstractings may so balance each other that the relative proportions of the two in the atmosphere as a whole may be little disturbed, but even this need not imply that we are reducing the total mass of the air by the amount of its constituents which we take from it by our modern mechanical manipulations. Whatever we seem to get we cannot get away with an atom of it. We can at the most only borrow, and our borrowings are "returned to stock" in spite of us.

We have to remember nature's automatic and constant restorative processes. The wonderful increase in our industries in the last hundred years has entailed the burning of coal, and now oil, in vast and increasing quantities, and this results in throwing off into the atmosphere incalculable volumes of carbon dioxide, and this alone might ultimately render life on the earth impossible, only that the process does not end with our doings. As we increase the burden of carbon dioxide in the atmosphere by all this active combustion, in addition to the slow combustion in our lungs and those of all breathing animals, we stimulate plant life by which the carbon is digested out and the oxygen is returned to the air to act as a carrier or go-between over and over again.

It may be safely assumed that the more carbon dioxide there is in the air, the more rapid and luxuriant will plant growth become, especially the rapid growing annual plants upon which we depend for food, these in the aggregate presenting vastly greater air contact surfaces than do the more impressive tree structures. So far as we can see, the result of artificially increasing the production of carbon dioxide, thus stimulating plant growth, is beneficial to the human race rather than otherwise.

If the matter is sufficiently looked into it will be found that nature's processes provide also for the restoring of nitrogen to the air if by any other agencies it may be abstracted, so that the balance of atmospheric constituents is maintained from this side also. It is a curious thing that nitrogen, the larger component of the air has been less minutely investigated, and the ramifications of its functions are less definitely known than those of oxygen.

It is well understood that plant growth persistently abstracts nitrates from the soil, and that in successful agriculture these must be artificially replaced, but it is coming to be recognized that there are certain plants which add to the nitrate constituents of the soil, so that these may be made to assist each other; and the further we go in our investigations the more do we discover these automatic compensations.

So far as we may think we decipher at all the ultimate plan of things we may well believe that the atmosphere is made for free and universal use, that any human being may do with any portion of it whatever he will, that the entire human race may do the same, getting whatever benefit and satisfaction they can out of it without the slightest occasion for self reproach or anxiety as to any damages that may be entailed. Fresh air, pure air will always be accessible to us all whatever we may do to impair it, if we only go a little way from our crowded haunts.

PNEUMATIC TOOL GENERALITIES

We have to take our mechanical inventions in the order in which they come to us, and we do not always get first the thing that is most wanted. The great opportunity for the use of compressed air as a relief and helper in the most exacting details of manual labor in the shops was long ago recognized, though perhaps few realized at first how much it would be able to do for us.

The most tedious and fatiguing of the workman's tasks have been eliminated, and at the same time his output has been increased and improved, but neither he nor his employer has had much choice as to the tools that should be first provided and has had to take them in the order in which they have happened to come.

In the getting up of air operated tools for the shop, or for portable use anywhere, why should the percussive tools have so long preceded the rotative tools when the latter form so large a portion of the tools normally employed? If any regard was had to actual practice, and to the demand which might have been predicated from it, the percussive tools and the rotative tools should have been started out together, or, if anything, with the latter somewhat ahead. Not only is there a great demand for handy rotative power for drills, taps, reamers, for grinding-in valves, for tube beading, for wood augers, for emery wheels when carried to the work, etc., but the number of these operations is continually increasing, while chipping and work of that character tends rather to decrease.

Well, the rotating drill, or drill driver, has arrived and, as usual, it has not come by the most direct route. There is perhaps nothing more common, and at the same time more curious, than our persistent placing of the cart before the horse in the process of developing our mechanical and other inventions. The more obvious arrangement of the horse before the cart is generally the last to be arrived at, and simplification taxes ingenuity more than complication does. The most perfect and effective contrivances we produce are ultimately the simplest, but the simplicity is only attained after complication upon complication have first been devised and adopted and then have been tediously eliminated.

We like to make a fuss in our doings whatever they may be, and mechanical fuss or complication has its attractions for us. Some things seem to get a start in popular estimation from the beginning just from the imposing array of details they present. The very size and the full war panoply of Goliath assured him of victory in advance, but the smooth stone from the brook and the shepherd's sling scored the knockout.

The rotative drill, as now simplified nearly to perfection, makes very complete the pneumatic kit of the metal worker especially, so that it is now difficult for the inventor to find any more wants to fill in that direction. What more, for instance, can be done for the boiler maker? Only a quarter of a century ago his trade was one consisting of hand operations almost entirely, and now there is scarcely any hand manipulation—if we are permitted the tautology—left for him, while his former wonderful manual dexterity in riveting is becoming one of the lost arts, lost for want of exercise on the one side and for the lack of any market for such skill on the other.

With air hoists and jacks to begin with, the complete line of pneumatic hammers, riveters, chippers, caulkers, and then the rotative tools for the other operations, the trade once so dependent upon manual skill is now most independent of it.

Perhaps nothing so wonderful and complete in trade transformation as this, or accomplished in so short a time, can be found in history, and the effective agents have been the series of devices comprised between the air compressor and the little rotative drill.

NATURAL GAS TRANSMISSION AND DISTRIBUTION

For the following sketch of the Cincinnati natural gas service we are indebted to Mr. Wm. A. Miller, General Manager of the gas department of the Union Gas and Electric Company, Cincinnati, Ohio.

Natural gas from the Ohio fields has been supplied by the Company since October, 1908, to that portion of Cincinnati, Norwood and adjacent villages north of the line of McMillan Street, and to all of Cincinnati, Norwood, adjoining villages, and Covington, since July 1st, 1909. The pipe line from near Culloden, W. Va., to Cincinnati, was completed and natural gas supplied through it (as stated) July 1st, 1909, since which time the service has been uninterrupted to all of our domestic customers.

The pipe line referred to, consists of 123 miles of 20-inch seamless steel pipe, extending from Cincinnati to the Big Sandy River Compressing Station, and 33 miles of 18 inch seamless steel pipe, extending from the Big Sandy River to the end of main line near Culloden, W. Va. From the 18 inch main pipe line there are about 40 miles of lateral 12 and 8 inch pipe lines extending to, and penetrating the gas fields which embrace about 300,000 acres (the latter the property of the Columbia Gas and Electric Company) on which there are now drilled about 100 gas wells having an open flow of approximately 200 million cubic feet per day. These wells are, in the opinion of the Company's Engineers, capable of supplying the city of Cincinnati and adjacent villages and towns, for more than 30 years.

The West Virginia Pipe line, used in connection with our storage holders (having a capacity of 10 million cubic feet) is capable of transporting to our consumers upwards of 75 million cubic feet of gas daily, with an initial pressure of 320 pounds at Compressor Station, and a terminal pressure of about 60 pounds at Cincinnati. The distribution system of the City of Cincinnati and villages adjoining, consists of about 45 miles of belt line in the form of a figure 8, outlining the whole territory to be supplied, upon which a pressure of from 3 to 5 pounds is maintained, varying with the demand for gas and temperature of atmosphere.

From the belt line the gas is caused to pass through forty-two district regulators set in masonry pits, and located in streets in different parts of the City and villages supplied, which are adjusted for maintaining a pressure of 5 ounces on their outlets. The outlets of the regulators are connected to our low pressure system of mains, consisting of about 650 miles of all sizes of main pipes, from 4 to 30 inches in diameter. Individual house regulators are only used where the belt line is the only main from which a supply of gas can be obtained for the customer to be supplied.

CARRARA QUARRYING METHODS

Consular Agent Felix A. Dalmas, Carrara, Italy, sends an interesting account of the marble quarries there and the methods of working. As will be noted, compressed air and the channeling machine are both conspicuously absent.

CAUSES OF SLOW DEVELOPMENT.

The jagged, rough, precipitous character of the Apuan Alps and the peculiar geologic formation of the deposits, which can be expressively likened to a tortuous, broken puzzle, difficult of access, account in a great measure for the slow and unique manner in which the Carrara industry has developed as compared with the marble industry, in America. But the main reason for the slow development and improvement is the lack of unity on the part of the quarry owners and the extreme individualism indulged in instead of cooperating for the conservation of the natural resources and the improvement of the industry.

It can not be denied, however, that a strong effort is being made toward conservation and economy of operation on the part of the larger Carrara firms and a few progressive quarry owners who thoroughly understand the situation and desire to improve the industry, but their problems are not easy. Yet, wasteful as the methods have been in the past, the last few years have brought great improvement.

With no other tools than sledge and wedge the Etruscans, two or three centuries before the Christian era, split the marble from the low, outcropping strata by main force. They were followed by the Romans, who continued the industry intermittently until the fall of their Empire. After that the quarries were probably forgotten. For centuries, so far as is known, no marble was quarried. With the religious awakening and fervor of the eleventh and twelfth centuries a great demand for marble was created, which, followed by the artistic activity of the fifteenth century, gave the industry an impetus which has lasted to the present time.

QUARRYING METHODS.

It is doubtful if there was any great improvement over the original methods of quarrying until blasting powder was invented and used. This wasteful process, by which hundreds of tons are displaced at one time, is still in use to a great extent, although it is being rapidly replaced, wherever possible, by the endless, spiral grooved wire, which is usually about 500 meters (1,640 feet) long, working tightly stretched over a system of pulleys attached to standards, two of which, fitted with automatic pressure screws, are placed on either side of the section to be cut. Hard sand, brought especially for the purpose from near Viareggio, is mixed with water and allowed to flow in a steady stream under the rapidly moving wire. This produces a clean cut. The 500-meter wire working at full capacity will cut a surface of approximately 700 square feet in 48 hours, and consumes in that time 9 metric tons of sand.

Electric power is generally employed in the quarries, but there are a few gas and oil engines in use and five small hydraulic power plants. The total horsepower employed in the quarries is 635 electric, 70 hydraulic, 42 steam, 168 gas, and 81 oil.

THE PENETRATING PULLEY.

A few years ago a new Carrara invention called the penetrating pulley was put into use, and this proves of great advantage where cuts are made in a solid floor, thereby eliminating the need of sinking more than one shaft or channel. Simply explained, the penetrating pulley is a thin steel disk with a shallow grooved edge around which the spiral grooved wire passes and projects beyond the edge. The pulley is rigged with a swivel on the end of an automatically operated screw; which is supported by struts and braces that are wired to rings firmly embedded in the floor in order to resist the downward pressure of the screw. A 1½-inch hole, to admit the screw, is first drilled to the desired depth. This acts as a lead to the disk which forces the projecting and rapidly moving wire into the marble.

The penetrating pulley can be worked at only one corner of a desired cut. At the other end an ordinary standard must be rigged, after first digging a channel in from the face of the cliff. In this way masses of marble containing as high as 5,000 cubic feet and weighing approximately 390 metric tons are cut loose. To displace this mass a wedge-shaped section, the apex terminating at the point of gravity, is cut from the base; a small charge of blasting power exploded in the rear cut tips it over, where it can be divided as desired. This manner of quarrying eliminates the necessity of squaring up the blocks, as is the case when the marble is blasted loose, and is naturally very economical. The penetrating pulley may now be said to be in general use. In 1911 pneumatic drills were installed in a few of the quarries.

One of the most serious problems for the quarry owners to contend with is the enormous quantity of waste that has accumulated for centuries: It often so interferes with the operation of a quarry as to make the work unprofitable. The encroachment of waste from a neighboring and higher quarry is a frequent 'cause for litigation to decide priority rights, and as a consequence many good properties have been lost and many quarries are closed by force of injunction.

EXPORTING WATER POWER

The main factor in obtaining a cheap supply of carbide of calcium is of course the power, so that the carbide industry has become localized near sources of cheap water power. At the same time the carbide produced is mostly used in widely distant localities and often in other countries, and in the latter case the exportations are if not of actual water power at least of most direct products of it. In the table below it will be seen that of the product of Sweden and Norway 92 per cent. is exported; of Switzerland, 86 per cent., and of the United States 26 per cent. At the same time Germany imports 80 per cent. of the total amount of carbide it uses; England, 87 per cent., and other countries, taken in a lump, 92 per cent.

Countries.	Made.	Used.	Exported.
Sweden and Norway......	52,000	4,000	48,000
United States..............	50,000	37,000	13,000
France......................	32,000	31,500	500
Switzerland................	30,000	4,000	26,000
Italy.........................	28,000	23,000	5,000
Austria and Hungary......	22,500	17,000	5,500
Canada......................	12,000	8,000	4,000
Spain........................	18,000	16,000	2,000
Germany....................	7,000	36,230	....
England.....................	2,000	16,000	....
Other countries............	5,200	63,800	....

DOES OXYFEN GRAVITATE DOWN THROUGH THE AIR

It is quite generally understood that compressed air delivered by the Taylor hydraulic compressor has less than the normal proportion of oxygen. In an interesting article in a recent issue of *The Engineering and Mining Journal,* describing the Buffalo Mine at Cobalt, Ontario, which is supplied with compressed air from a Taylor hydraulic compressor, the following occurs:

"When this air was first introduced some trouble was experienced, as candles would not burn in close stopes where it was used. By driving a raise in these close places the trouble was overcome and now candles are used except in one or two especially long drifts where carbide lamps are necessary. While the lack of oxygen in this air caused trouble with the candles no ill effects are noticed by the miners nor have any of them suffered any effects since its introduction over two years ago."

Oxygen is one-tenth heavier than air while nitrogen is one-twenty-fifth lighter, and air is not a chemical compound but a mechanical mixture. From the experience outlined in the above paragraph it would appear that the oxygen is affected more or less by gravity so that with the raise spoken of, giving vertical depth to the body of air, the oxygen may settle down through it more or less while the nitrogen would correspondingly rise, with the improvement or enrichment of the lower strata as noted.

NOTES

The belting used in the Baku (Russia) oil fields is principally that made from camel's hair; the leather, rubber and cotton belting does not withstand the action of the oil so well.

For nine months ending March, 1912, there were exported of napthas and other lighter products of distillation of natural gas 102,722,964 gals., valued at $8,763,619; in 1911 the figures were for the same period, 69,467,943 gals., valued at $6,163,525. For the same period in 1910 the figures were 49,041,971 gals., valued at $3,930,912.

Inventions are constantly outrunning each other. There is much complaint now that drill steel does not stand up to its work. It does not appear that the quality of the steel has deteriorated, but that more is required of it to meet the conditions of modern drills which have been greatly improved in intensity of operation and mechanical efficiency.

A serious explosion, causing the death of one person, occurred on the steam yacht Cristina in New London harbor. The owner is sure that no explosives were on board, and an explanation suggested is that hydrogen liberated from the electric storage batteries, which were in a tight compartment aft, mixed with air and that the mixture was ignited by a spark.

It is reported that the Turkish council of state is studying a plan for an underground the Golden Horn. A more ambitious plan. railway to connect Stamboul with Pera, under which English engineers are said to have in hand, contemplates a double tube under the Bosporus, between the extreme points of Stambul and Haidar Pasha, to connect the railway systems of European and Asiatic Turkey.

"It is stated" that the active officers of the Siamese Army have agreed voluntarily to forego a portion of their pay for 12 months in favor of the establishment of a fund for the purchase of heavy guns. And what will they do with the guns when they get 'em?

Moving pictures are to be used by the Central Georgia Railroad to teach the elements of railroading to the more ignorant of the employes, many of whom are illiterate. It is believed that by substituting pictures for textbooks they can be taught to perform their duties more intelligently. Almost every detail of train operation can be shown effectively on the screen, and the pictures can be run over as many times as may be needed to teach the processes thoroughly.

When slime is treated with sufficient lime to neutralize the ferrous sulphate and sulphuric acid the former is precipitated as ferrous hydroxide, which at once absorbs all the oxygen in the slime, and only a small percentage of which is changed into ferric hydroxide. Air lift agitation quickly introduces more oxygen, and at once changes the ferrous hydroxide into ferric hydroxide, and introduces the excess of oxygen, which is necessary for perfect conditions in cyaniding.

The world's largest Curtis steam turbine, which drives an electric generator in the Waterside station, New York, develops 30,000-h.p. If it takes twelve men to equal 1-h.p., then this turbine engine develops twelve times 30,000, or the working energy of 360,000 men. If these men worked in eight-hour shifts each day, it would require the services of 1,080,000 men every twenty-four hours to produce the working energy of this single turbine unit.

The empty gasoline or kerosene can is a blessing to the denizens of the desert. Four of them filled with water make just the right load for a jackass. One holds just a dime's worth of water. Split endwise, a bachelor's dishpan is the result. An experienced housekeeper cannot do without them. Cut the top out of one and you have a vessel just the right size to boil a ham. Cut around three edges of one and you have a box with a door, which mice cannot molest. If the roof leaks cut up an oil can and patch it. If you want an ash pan, cut one in two and there you are. Partly fill half of one with ashes and you have a spittoon.

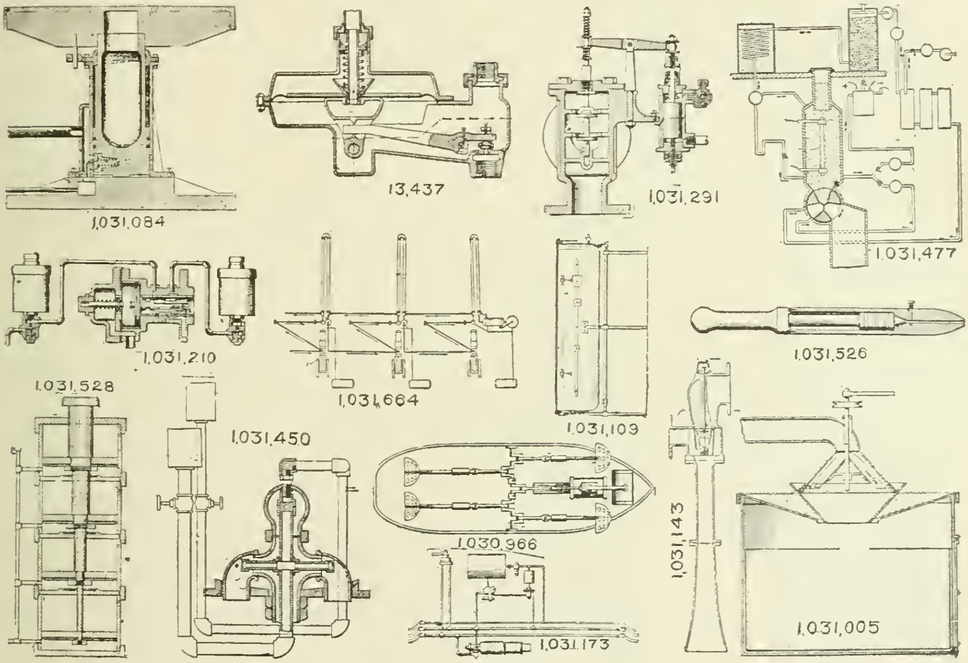
Injecting pure oxygen gas into the blood of airmen and mountain climbers, as an auxiliary supply to that inhaled into the lungs, is a remarkable means proposed for the prevention of the so-called mountain sickness, which is due to the rarity of air at high altitudes. The preventive treatment, which was described together with the experiments confirming its efficiency at a recent session of the French Academy of Sciences, consists simply in the subcutaneous injection of small quantities of pure oxygen gas, the effect of which is claimed to persist for several days.

In the Fourth of July contests this year Page and Pickens at Tonopah drilled 45 7-16 inches in Rocklin granite in 15 minutes. Lundquist and Dahlen, of Victor, Colorado, drilled 41 7-16 inches, and Porter and Goddard, of Oatman, Arizona, 38 7-16. At Lowell, Arizona, a shoveling contest was held, the task being to shovel two tons of ore over a partition three feet high. The prize of $100 was won by Henry Arnes, who completed the task in 8 minutes. His nearest competitor, Frank Travers, was 26 seconds slower. The motion study sharps could take hold here and show these men how.

In the vicinity of Newman, Cal., an energetic young man who believed that vacuum carpet cleaners could be sold in the country as well as in the city is responsible for the death of millions of grasshoppers in that city, and many alfalfa ranches whose parlor floors boast no carpets, have become his patrons. Noticing the desperate expedients made to rid gardens of grasshoppers he mounted a cleaner on a light sled and pushed it before him on the alfalfa. The hoppers jumped before it as it reached them and were drawn by the suction into the machine. The farmers have added to the economic advantages of the system by drying the hoppers and sacking them for chicken feed. So they say.

The Baldwin Locomotive Co. has been accumulating land for some time at Ridley Park, Pa., near its Eddystone works, for the purpose of colonizing its employes. At the present time most of them live at Philadelphia and are forced to commute daily. Although the company has made no definite statement, it is understood that substantial houses will be erected and that they will be rented at a very low rate.

A task of great magnitude is being undertaken by the Japanese Home Department in the dredging of the Straits at Shimonoseki. For this purpose a large number of dredges are required, and there has just been launched at Uraga the dredger *Noda Maru*, which is a powerful vessel capable of dredging at a depth of 40 feet. The work contemplated will take 10 years, and the estimated outlay will be $6,750,000. A channel 17½ miles long and 3,600 feet wide will be deepened to 33 feet. The *Noda Maru* is the latest and biggest vessel to be engaged in this work, the object of which is not only to aid commerce, but to provide an anchorage for dreadnoughts.



Pneumatic Patents, July 2.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 2.

1,030,871. FLUID-ACTUATED TOOL. Charles T. Carnahan, Denver, Colo.
1,030,966. PNEUMATIC PROPELLING MECHANISM. Thomas W. Black, Chicago, Ill.
1,031,005. SUCTION APPARATUS. Louis Isaacs, Louisville, Ky.
1,031,007. SIPHON. Edward M. Johnson, Jersey City, N. J.
1,031,084. SAND-MOLDING MACHINE. William C. Norcross, Terre Haute, Ind.
1,031,109. RESUSCITATING APPARATUS. William G. Euston, St. Louis, Mo.
1,031,141. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Gustave P. S. Miller, Brooklyn, N. Y.; Nellie Anderson administratix of said Miller.
1,031,143. HYDRAULIC AIR COMPRESSOR OR PUMP. Otto H. Mueller, Camberwell, England.
1,031,151. PNEUMATIC PUMPING APPARATUS FOR VACUUM-CLEANERS. John W. Smith, Chicago, Ill.
1,031,168. FLUID-ACTUATED TOOL. Charles T. Carnahan, Denver, Colo.
1,031,173. FLUID-PRESSURE REGULATOR. Clyde C. Farmer, Chicago, Ill.
1,031,176. COMBINED NOZZLE SPRAYER, AND SPRINKLER. Albert D. Gilpin, Lincoln, Neb.
1,031,210. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.
1,031,291. PRESSURE-GOVERNOR. George M. Richards, Erie, Pa.
1,031,450. FUEL-OIL BURNER. Martin L. Kline, Agricola, Kans.
1,031,477. PROCESS OF BINDING AND UTIL-

IZING AIR-NITROGEN. Alf Sinding-Larsen, Christiania, Norway.

1,031,526. GUN. Newton Heston Cloud, Jr., Wilmington, Del.

1,031,528. SECTIONAL CYLINDER AIR-JACK. Charles Henry Cole, Pueblo, Colo.

1,031,617. AUTOMATIC AIR-BRAKE COUPLING. Eli Bixler, Berne, Ind.

1,031,664. ART OF THE CONDENSATION OF GASES OR VAPORS INTO THEIR LIQUID FORMS. Franklin P. Peterson, Grove City, Pa.

1. The art or process of condensing and separating differing compounds in natural gas in which there are different critical pressures and temperatures which consists in compressing and cooling the gas and collecting the liquid condensed and then compressing and cooling the gas residue and collecting the liquid from the residue.

13,437. (Reissue). GAS-REGULATOR. Arthur L. Pickering, Anderson, Ind.

1,031,816. PNEUMATIC-DESPATCH-TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

1,031,834. FLUID-PRESSURE ENGINE. Benjamin Brazelle, St. Louis, Mo.

1,031,838. BEER-SAVING APPARATUS. Joseph Choquette, St. Hyacinthe, Quebec, Canada.

1,031,875. PNEUMATIC CAR DUMPING AND RIGHTING DEVICE. Nicholas Schaefers, Ludlow, Ky.

1,031,884. VACUUM-BOTTLE. Louis J. Stilling, Newark, N. J.

1,031,957. FENDER. William Francis O'Rourke, Philadelphia, Pa.

1,032,040. HYDROPNEUMATIC PLUNGER-ELEVATOR. Leonard Atwood, Farmington Falls, Me.

1,032,052. PRESSURE-REGULATOR. Ernest W. Evans, Robinson, Ill.

1,032,141. PNEUMATIC-DESPATCH-TUBE APPARATUS. Chester S. Jennings, Boston, Mass.

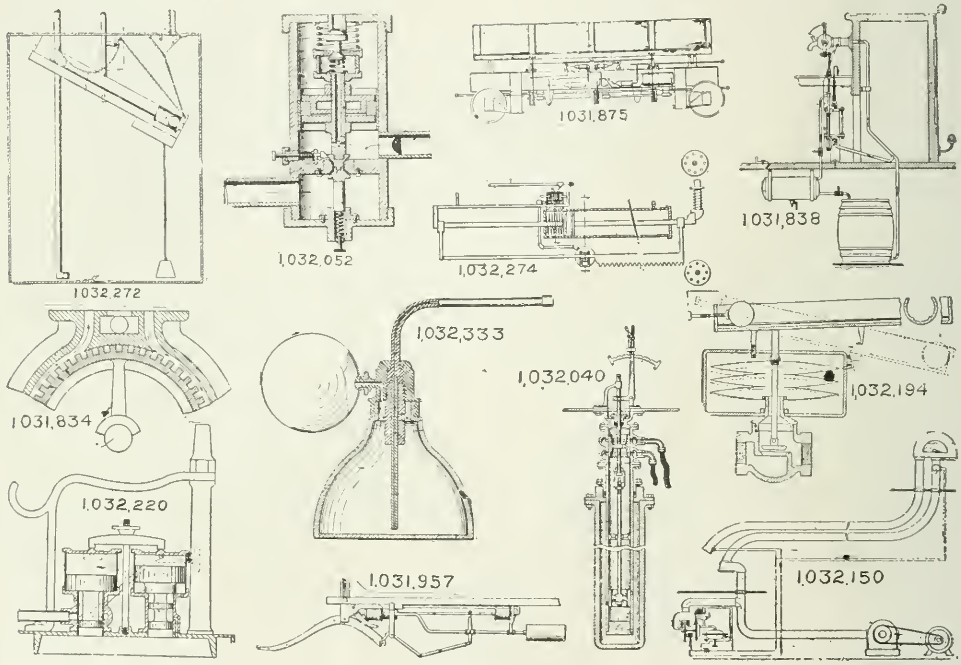
1,032,147. TURBO-COMPRESSOR. Ernst Wilhelm Koster, Frankfort-on-the-Main, Germany.

1,032,150. PNEUMATIC-DESPATCH-TUBE APPARATUS. James G. Maclaren, Weehawken, N. J.

1,032,155. PNEUMATIC-DESPATCH-TUBE APPARTUS. Albert W. Pearsall, Lowell, Mass.

1,032,194. AUTOMATIC GAS-VALVE. Robert T. Evans, and Walter G. Nord, Youngstown, Ohio.

4. In a device of the character described, the combination with fluid-pressure operated mechanism; of means, including a cylindrical runway oscillatorily mounted upon a horizontal axis, and a weighted ball adapted to move in said runway upon oscillation thereof, said means being operated by said mechanism upon a change in such fluid-pressure and being adapted thereupon to retain said mechanism in a fixed position



Pneumatic Patents, July 9.

JULY 9.

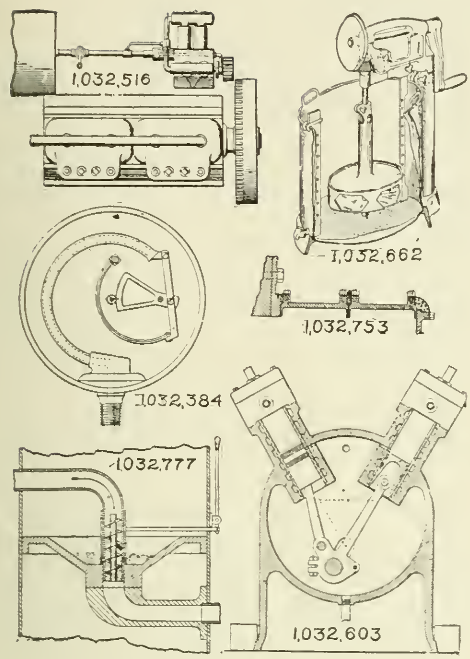
1,031,742. PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles F. Stoddard, Boston, Mass.

1,031,774. TERMINAL FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. James T. Cowley, Boston, Mass.

1,031,801. VACUUM-PUMP. Harry D. Madden, Bloomfield, N. J.

1,031,814. PROCESS OF PRODUCING PLASTIC SUBSTANCES FROM MILK. Ottokar Henry Nowak, Chicago, Ill.

4. The process herein described for the manufacture of milk products consisting in eliminating soluble matters from the curd of milk, dissolving the coagulum under agitation, re-coagulating the solution under agitation by an acid or acid salt, adding a ketone to the coagulum, comminuting the coagulum in water, expressing the water from the mass, forming the mass into layers, and drying the layers under pressure in a vacuum.



Pneumatic Patents, July 16.

against succeeding changes in pressure; and a screw-bolt mounted at the normally lower end of said runway and adapted to position said ball therein, thereby permitting operation of said first-named means only upon a predetermined change in such fluid-pressure.

1,032,220. ELASTIC-FLUID MOTOR FOR MILKING APPARATUS. Albert Kilborn, Middle Brighton, Victoria, Australia.

1,032,272. COMPRESSED-AIR WATER-ELEVATOR. Arthur O. Brown, Chicago, Ill.

1,032,274. DEVICE FOR STARTING INTERNAL-COMBUSTION ENGINES. David Eldridge Crouse, Annapolis, Md.

3. In a device for starting internal combustion engines, a pinion on the engine shaft, a pivoted rack arranged to engage said pinion, a spring for moving said rack into engagement with said pinion, pneumatic means for swinging the rack out of alinement with said pinion, pneumatic means for retracting the rack when out of alinement with the pinion, and for compressing said spring, and a second spring for swinging the rack into its original position.

1,032,333. ATOMIZER. William S. Hay, Providence, R. I.

JULY 16.

1,032,384. PRESSURE-GAGE. Robert M. Dixon, East Orange, N. J.

1,032,516. ENGINE-STARTER. William L. Stuller, Detroit, Mich.

1,032,603. AMMONIA-COMPRESSOR. William H. Hayner, Fort Wayne, Ind.

1,032,663. AERATING BUTTER-SEPARATOR. Alpheus Fay, Louisville, Ky.

1,032,753. GAS AND AIR TIGHT JOINT. Burt S. Harrison, New York, N. Y.

1,032,777. SAND-BLAST APPARATUS. Ludwig Sauer, Kitzingen, Germany.

1,033,000. PNEUMATIC PIANO-PLAYER. Joseph Leslie Forster, Vancouver, British Columbia, Canada.

1,033,010. MANUFACTURE OF PNEUMATIC CUSHIONING DEVICES FOR THE ELASTIC SUSPENSION OF ROAD-VEHICLES. Leonard Harris, London, England.

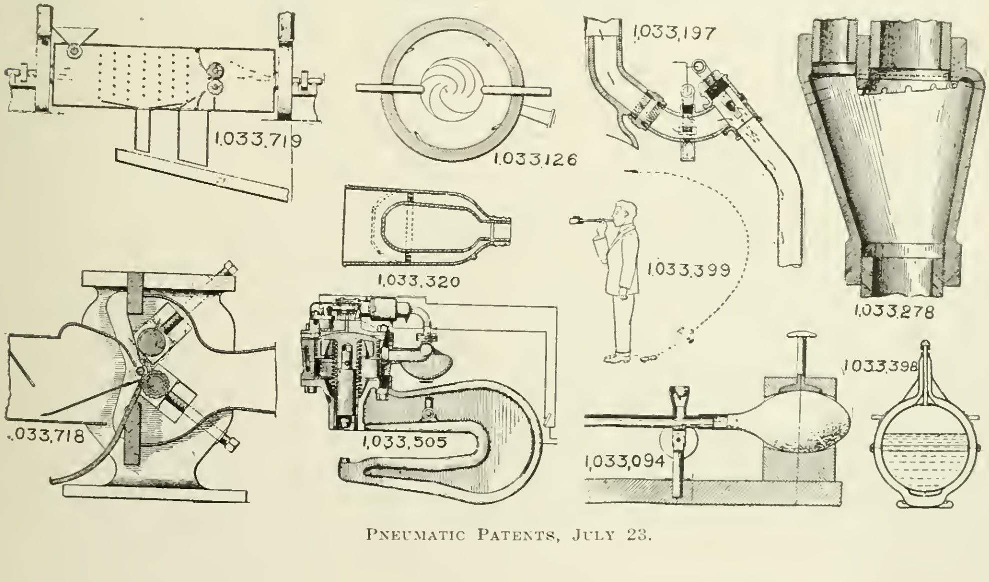
JULY 23.

1,033,094. TARGET AIR-GUN. Ralph Fuda, Norfolk, Va.

1,033,126. METHOD OF PRODUCING ENDOTHERMIC COMPOUNDS FROM THEIR COMPONENTS. Werner Siebert, Rheinfelden, Baden, Germany.

2. The method of producing nitric oxids from the air, consisting in forming an arc in the center of a cylindrical electric furnace between electrodes, the points of which are in a horizontal plane, forcing the air through nozzles distributed along the inner periphery of the furnace at so great a speed as to produce within the furnace a violent whirl of air capable of horizontally spreading the air, whereby a disk-shaped flame is formed, the heat of which can combine the essential components of the air to form nitric oxids, and in discharging the nitric oxids formed from the furnace.

1,033,197. TRACK-SANDING APPARATUS.



Pneumatic Patents, July 23.

Frederick Rothwell, Montreal, Quebec, Canada.

1,033,216-7. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Eugene T. Turney, Rock Island, Ill.

1,033,278. AIR-LIFT. John P. Simmons, San Francisco, Cal.

1,033,320. VACUUM WALL-RECEPTACLE. Orlando J. W. Higbee, Pittsburgh, Pa.

1,033,398. METALLIC VESSEL FOR LIQUEFIED GASES. Christian Wilhelm Paulus Heylandt, Schulau, Germany.

1,033,399. AERIAL TOY. George Heylman, North San Diego, Cal.

1,033,438. PNEUMATIC PLAYER FOR MUSICAL INSTRUMENTS. William T. Miller, Boston, Mass.

1,033,505. POWER DEVICE. Morris C. White and Otho C. Duryea, Chicago, Ill.

1,033,718. PNEUMATIC COTTON-GIN. John J. McNally, Norfolk, Va.

1,033,719. SEED-COTTON SEPARATOR. John J. McNally, Norfolk, Va.

1. A seed cotton separator comprising an air blast chamber, and separator rolls in the path of the blast moving in contact with one another, one of said rolls being fluted longitudinally and the other being channeled circumferentially.

1,033,923. WAVE-MOTOR. Jacob Nyswander, Puente, Cal.

1,033,993. LAUNCHING TORPEDOES. Gregory C. Davidson, Quincy, Mass.

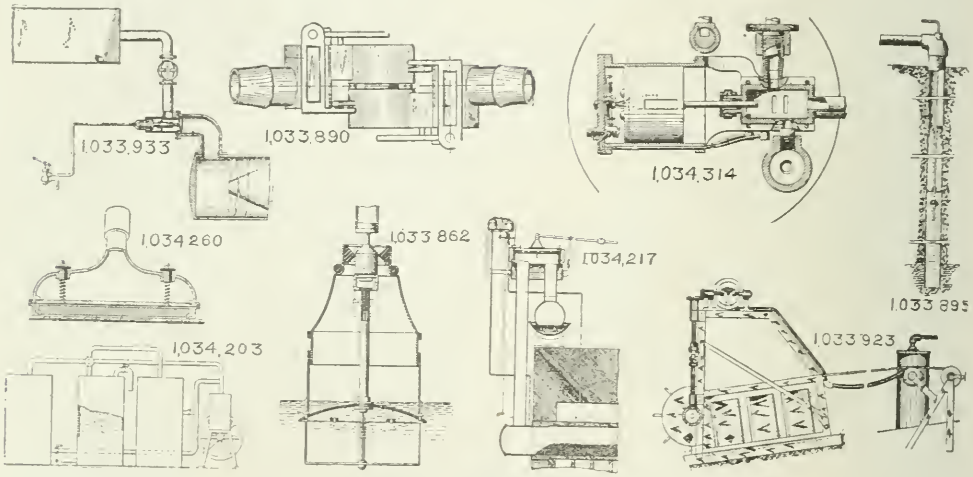
1. In torpedo launching apparatus, a launching tube, a reservoir for motive fluid under pressure, and a conduit for the motive fluid from the reservoir to the space within the launching tube about the torpedo, in combination with pressure controlling apparatus in said conduit for limiting the pressure on the torpedo and maintaining it substantially uniform as the torpedo moves forward in the launching tube.

1,034,052. DRILL FOR ROCK, COAL, AND OTHER MATERIAL. Samuel S. Wyer, Columbus, Ohio.

1,034,203. PROCESS OF AGGLOMERATING MATERIALS. Paul Claes, Brussells, Belgium.

1,034,215-6. APPARATUS FOR REMOVING SUSPENDED MATTER FROM GASES AND VAPORS. Henry L. Doherty, New York, N. Y.

1,034,217. METHOD OF EQUALIZING PRESSURES. Henry L. Doherty, New York, N. Y.



Pneumatic Patents, July 30.

JULY 30.

1,033,788. BUST-FORM. Oliver C. Dennis, Chicago, Ill.,

1,033,862-3. ACETYLENE-GAS GENERATOR. Charles W. Beck, Rockville, Center, N. Y.

1,033,865. PNEUMATIC ELEVATOR. George Bernert and Jacob Bernert, South Germantown, Wis.

1,033,890. AIR-HOSE COUPLING. Murray Hendricks, Benwood, W. Va.

1,033,895. AIR-LIFT PUMP. Julius H. Holmgreen and William H. Underwood, San Antonio, Tex.

1. In an air-lift pump, a water-discharge pipe open at its lower end, an air-supply pipe leading into the lower part of the water-discharge pipe, and an atomizer in the lower part of the water-discharge pipe communicating with the air-supply pipe, said atomizer comprising a shell with numerous small air-passages leading through its wall in upward and outward directions and said shell having a sediment-eduction opening in its bottom.

1,033,918. CAR-VENTILATOR. Joseph T. Mercier, Chicago, Ill.

1,034,230. ENGINE-STARTING APPARATUS. Edward A. Halbleib, Rochester, N. Y.

1,034,260. PNEUMATIC CLEANING APPARATUS. Erich H. Lichtenberg, Milwaukee, Wis.

1,034,314. PULSATING MECHANISM FOR MILKING-MACHINES. David Townsend Sharples, West Chester, Pa.

1,034,317. PNEUMATIC WHEEL. Albert Herman Smith, Topton, Pa.

1,034,335. METHOD OF AND APPARATUS FOR MAKING CORES. John C. Bannister, Kewanee, Ill.

1,034,336. METHOD OF AND APPARATUS FOR MAKING MOLDS AND CORES. John C. Bannister, Kewanee, Ill.

13,450. (Reissue). STARTER FOR INTERNAL-COMBUSTION ENGINES. Luther V. Moulton and Palmer A. Jones, Grand Rapids, Mich.

1. An engine starter, comprising mechanism for distributing fluid under pressure to the respective engine cylinders in succession, a throttle valve adapted to control the flow of said fluid and manually operated means for simultaneously operating said mechanism and throttle valve.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVII OCTOBER, 1912 No. 10

ABSTRACTION OF ATMOSPHERIC NITROGEN*

The two main sources of fixed nitrogen are sulphate of ammonia from gas-works, etc., and sodium nitrate from Chili. The production of the former in Great Britain amounted, in 1910, to about 370,000 tons, and the export of the latter from Chili about two and a half million tons per annum.

Against these figures the output of calcium nitrate and calcium cyanamide, which are two of the main products of the electric fixation of nitrogen processes, seem small. The important thing to notice, however, is that electrical processes are now on a sound commercial footing, and very large extensions of plant have been made recently.

Although the first experimental plant was started only nine years ago, already the company controlling the patents of the direct process of Professor Birkeland and Mr. Sam Eyde for the manufacture of calcium nitrate, have installations aggregating 200,000 horsepower at work.

The other electrically-produced nitrogenous manure, calcium cyanamide, is made by a more indirect method invented by Dr. Franck and Dr. Caro.

The Birkeland-Eyde furnace depends on the inter-action of an alternating-current arc in a constant magnetic field. The furnace, as installed at Notodden, consists of a circular sheet steel drum about 8 feet in diameter and 2 feet wide, lined with refractory fire-brick, and having a disc-like space in the center, 6½ feet diameter and 1¼ inches wide. Air is supplied at the center of the furnace by a Root blower, while a channel round the periphery of the disc space carries off the gases and oxidized air, as shown in Fig. 1.

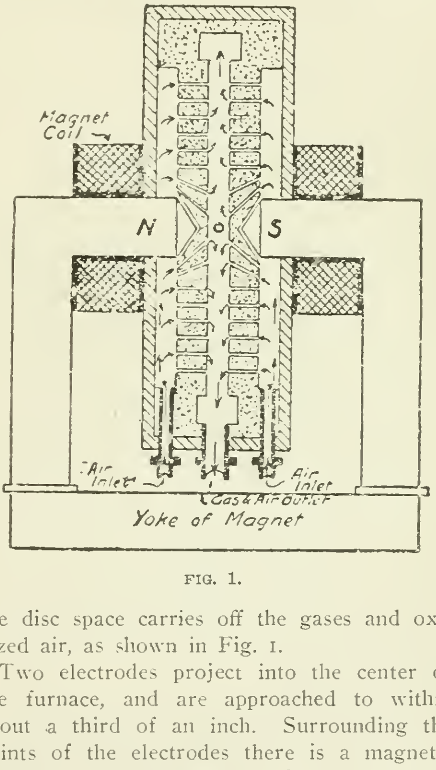


FIG. 1.

Two electrodes project into the center of the furnace, and are approached to within about a third of an inch. Surrounding the points of the electrodes there is a magnetic field of about 4,500 lines of force per square centimetre. Alternating current at 5,000 volts and fifty periods per second is supplied to the electrodes, and direct current flows round the coils to produce the magnetic field.

When an arc is struck between the electrodes, it is at once deflected in a direction perpendicular to the lines of force, and the necessity of having alternating current applied to the electrodes will be appreciated from the fact that with direct current the arc would be deflected to one side only. As each

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*Ernest Kilbourne Scott, in *Journal of the Royal Society of Arts.*

electrode is alternatively positive and negative, the arc is projected outwards first to one side and then to the other, thus giving a disc of flame about 6 feet in diameter. The speed at which the arc moves outward is extremely rapid, and as the formation of a new arc is practically instantaneous, it appears to the eye as a sheet of flame.

When the extremities of the arc retire along the electrodes, the arc increases in length, its resistance also increasing, until the tension is such that a new arc strikes between the points of the electrodes. The resistance of this short arc being smaller, the tension of the electrodes suddenly sinks to a point that will not sustain the long arc, which is thus extinguished. Another arc starts, and so the process goes on.

As carried out at Notodden, the method of making calcium nitrate is as follows: The nitric oxide gas and air pass from each furnace into two fireproof-lined gas-collecting pipes, about 6 feet in diameter, lined with firebrick. These pipes convey the gas to four steam boilers, the heat given off by the gases being used to raise steam for concentrating the products and for driving the air compressors for pumping acids, soda, etc. The gases then go through tubes in the evaporating tanks, after which the temperature is down to about 250 degrees Centigrade. The temperature is lowered still further, to 50 degrees Centigrade, by passing it through a number of aluminum tubes over which cold water is flowing. The gas then enters the oxidation tanks, which are large vertical iron cylinders, having acid-proof linings. Here it continues to take up oxygen to form nitrogen peroxide, the percentages being now about 98 per cent. air and 2 per cent. nitrogen peroxide.

The nitrogen peroxide is brought into contact with water to form nitric acid, in two series of four towers. These towers are built of granite and are filled with broken quartz, this substance and the granite being chosen because they are not affected by acid. Each tower measures 2 metres square by 10 metres high, and it has been found that they will give an absorption of 3.3 kilograms of nitric acid per cubic metre of space per 24 hours.

The liquid trickles down through the quartz and meeting the nitrogen peroxide gas, combines with it. The liquid moves from tower to tower in the opposite direction to the gas. Thus the fresh water enters at the top of the fourth tower, it flows down through the interstices between the pieces of quartz and falls into a granite tank. From there it is pumped by compressed air to the top of the third tower, down which it trickles into another tank, thence by pumping to the top of the second tower, and so on. When the liquid reaches the bottom of the first tower it contains about 40 per cent. nitric acid. This 40 per cent. solution of nitric acid is sprayed over calcium carbonate, the carbon dioxide gas is driven off and calcium nitrate remains.

The solution is then pumped into solidification pans, under which cold air is circulated to accelerate cooling, and the nitrate of lime stiffens into a brittle, crystalline mass. The mass is then granulated, packed in barrels, and is ready for shipment.

With the Birkeland-Eyde process, one kilowatt-year gives 500 to 550 kilograms of nitrate of lime. The latter usually contains 13 per cent of nitrogen, which corresponds to about 115 kilograms of combined nitrogen.

The problem in the fixation of nitrogen is to raise the temperature as quickly as possible above the igniting point of nitrogen and oxygen, and then immediately to cool the fixed gas and draw it off. The temperature of the burning nitrogen and oxygen flame is lower than the igniting point by about 200 degrees Centigrade. There must be a "hot cold zone," that is, a zone wherein the temperature is enormously high in one part and as low as possible in another part. As the electric arc gives in an easy manner the temperatures above ignition-point it is principally used.

The Rjukan installation is situated in Vestfjorddalen, East Telemarken. The saltpetre factories are situated at Saaheim, and the hydro-electric power-plant on the Maane River, half a kilometre away. The annual production will amount to 70,000 tons of nitrate of lime and 8,000 tons of nitrite.

The furnace invented by Mr. H. Pauling, of Gelsenkirchen, Westphalia, was taken from the idea of the well-known horn-break lightning arrester. As installed at Gelsenkirchen and Innsbruck it consists of two hollow iron electrodes, arranged to form a vee, which at the lowest point is about 4 centimeters across. At this point there are two lighting knives, which can be approached to within a few millimetres, and are readily adjustable. The arc strikes across and runs up the diverging electrodes by reason of the natural convection currents, and the repelling action of its own magnetic field, but principally because of a blast of heated air from an air-duct immediately below. The arc diverges as it follows the shape of the electrodes, and it attains a length of about a yard. At each half-period of the alternating current a fresh arc forms, so that the result is the equivalent of a triangular sheet of flame.

An important feature is that the wall which divides the two parts of the furnace is hollow, and gas and air which has been through the furnace previously and been cooled, is blown through this central passage. This cool gas and air strikes into the top of the arc flame, and it serves to cool the gases which have just been formed. The two arcs are in series, and the furnaces work in sets of three, one to each phase. Each furnace, therefore, receives single-phase current at 6,000 volts, fifty periods per second.

At Gelsenkirchen there are twenty-four such furnaces, each taking 400 kilowatts at 4,000 volts.

The works of La Nitrogène Cie, at La Roche-de-Rame, Hautes Alpes, France, have nine Pauling horn-arrester furnaces of 600 horse-power each in operation, and nine more of 1,000 horse power each are being added.

Some idea of the efficiency of the plant may be obtained from the fact that Mr. Pauling guarantees 60 grams of 100 per cent. HNO per kilowatt-hour of electrical energy, measured at the entrance of the electric transmission line into the factory; and also that the electro-chemical plant proper will cost about 120 francs per kilowatt.

The Southern Electro-Chemical Co. of Nitrolee, South Carolina, has a 4,000 horse-power plant on the Pauling system for manufacture of calcium nitrate. Electric energy is generated in two water-power plants at Great Forks and Rocky Creek.

The discovery of calcium cyanamide came about as the result of a research by Dr. Franck and Dr. Caro, who were following on the lines of some previous work of Playfair and Bunsen. Their immediate object was to make cyanide of potassium for the recovery of gold from tailings, and they incidentally found that barium carbide absorbed nitrogen to form barium cyanamide. By using calcium carbide they obtained a similar reaction. It was then found that by treating calcium cyanamide with hot water it gave off ammonia and this gave rise to the idea of using it as a manure.

As carried out at the Odda Works, the calcium carbide broken into lumps is delivered to crushing machines, from which it passes to mills in which it is ground fine, the whole of these operations being effected automatically in an air-tight plant so as to prevent acetylene gas being given off.

The powder is then filled into electric furnaces, of which, in the first installation at Odda, there are 196, each holding 300 kilograms.

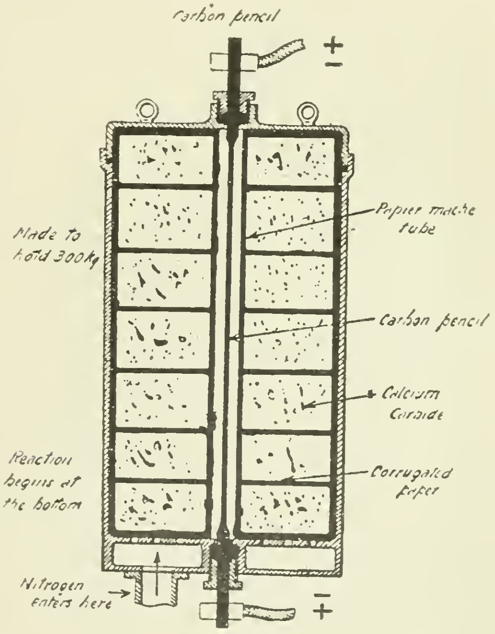


FIG. 2.

Fig. 2 is a rough sketch of the furnace, and it will be noticed that down the center there is a cardboard tube to provide a space for the carbon pencil. After the carbide has been filled in, the carbon pencil is fixed in position and the lid fastened down and made air-tight

Alternating current is now switched on, and the temperature is raised to 800 to 1000 degress Centigrade. The cardboard tube and certain carboard partitions which had been placed in the furnace when the calcium carbide was run in, are burnt up, and they leave spaces which allow the nitrogen gas, which is admitted under pressure, to circulate freely.

Electric current is kept on for twenty-five hours, and at the end of thirty-five hours all the nitrogen has been absorbed as shown by the meter.

The 196 furnaces make about thirty tons of calcium cyanamide, containing 18 per cent. of nitrogen, per day of twenty-four hours.

When it is turned out of the furnace the cyanamide looks like black clinker. After being broken up it is fed into jaw crushers, and then goes to roulette mills, where it is ground up fine for market.

Although calcium cyanamide is mostly employed as a manure, it has other uses. For example, by treating with superheated steam very pure sulphate of ammonia is obtained. Also the valuable constituents of modern explosives, ammonium nitrate and dicyandiamide, are made from it.

OXY-HYDROGEN POWER

Owing to the phenomenal rate at which the high-speed internal-combustion engine has been introduced, the price of the light oils has so advanced from the value of a waste product to the present price that other means are now being sought to obtain a fuel which may be produced at a greatly reduced cost. In this manner it has been proposed to use alcohol as a substitute for petrol (gasolene) the alcohol being extracted from peat, which in Ireland is so plentiful. Another substitute is now proposed by Mr. G. M. Ironside in the form of oxygen, for this gas, in combination with hydrogen, under pressure yields the greatest energy for a given space yet known, this energy manifesting itself in heat, light, and power, it being only necessary to bring these bodies under pressure to the ignition point to convert to a useful purpose. Recent experiments in the production of hydrogen go to prove that hot air or steam passed through a cylinder containing zinc or iron scrap and dilute sulphuric acid gives off hydrogen, and from the action of water on coke and lime we obtain the same results. Taking these two discoveries as the basis of his own experiments, Mr. Ironside utilized the heat given off from the exhaust of the ordinary type of the internal-combustion engine, passing the hot air over iron filings and dilute sulphuric acid in an acid-proof cylinder, and leading out the hydrogen thus made into a junction pipe running from the oxygen cylinder. The two gases were then run into a mixer and passed out again into the carbureter in the ordinary way, the only change from petrol power being the shutting off of outside air from the carbureter. With coke and lime made hydrogen the engine started cold, and it was found that the power developed was twice that when petrol was used, and the main defect noticed was an increased heating of the cylinder. With regard to the cost of the new power the inexhaustible supply is the surest means of keeping the price of this fuel at a minimum. The most economical mixture of hydrogen to oxygen found by these experiments was stated as one to eight by volume.—*The Practical Engineer*, London.

AVIATORS' SICKNESS

M. Berget, a French aeronaut, has been making a study of aviators' sickness which is different in character and degree from mountain sickness due to the rarefaction of the air in combination with the unusual muscular work of the climber and also from balloon sickness which does not appear except at very high altitudes. The additional and more potent factor in the case of the aviator is the rapidity with which the maximum height is reached and the still greater speed of the descent with the accompanying change of air pressures.

Aeroplanes sometimes reach altitudes of 10,000 feet in an hour, and here the effects on the ear such as humming or cracking noise are about the same as in a balloon, but the effect on the respiratory organs is different. The pilot is sooner out of breath and he feels a special kind of uneasiness. During the descent, the heart beats are of greater amplitude, but without accelerating. A quick descent in a sailing flight at a speed of 1,000 or 1,200 feet a minute or even more, since Morane descended at Havre from 8,000 feet height in 6 minutes, causes a feeling of a special kind, or uneasiness, accompanied with humming in the ears. Burning in the face is also felt and a severe headache, also the great tendency to sleep which has been before observed. The movements of the body are sluggish and unskilful. These symptoms continue for some time after the landing, and the tension in the arteries is noticed to be higher than the normal.

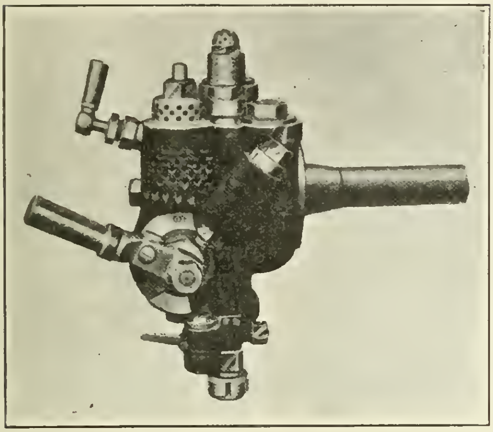


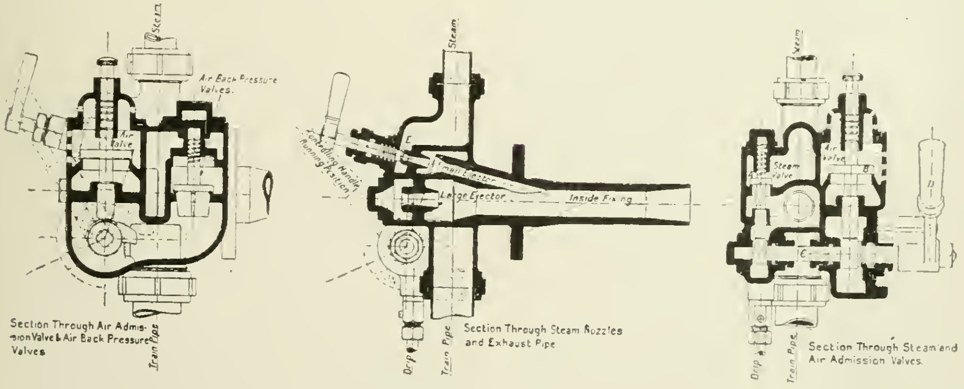
FIG. 1.

A STEAM ACTUATED EJECTOR FOR VACUUM BRAKES

The cuts show the essential features of an ejector used in connection with vacuum brakes made by Davies and Metcalfe, Limited, Rowiley, near Manchester, England. It is of the combined type with features differing from those embodied in similar appliances in general use. Fig. 1 is a general view of the instrument, and Fig. 2 shows the internal arrangements in section. The ejector embraces two separate steam nozzles, one large and the other small, each delivering through an independent orifice into a common exhaust pipe. The smaller nozzle—see the centre drawing in Fig. 2—is constantly in use for maintaining a steady vacuum when running, and the larger is used to obtain a quick release by restoring the vacuum after the application of the brakes.

The nozzles, as will be observed, are of the solid jet type, and are easy of access for inspection or renewal. They are screwed directly into the body of the instrument, and the joints are made steam-tight by means of faced collars. Steam for the nozzles is admitted by means of two separate valves. In the case of the small ejector the valve is direct-acting, with a seating on the end of the nozzle. The steam for the large ejector is controlled by means of a mushroom valve A, shown in the right-hand drawing in Fig. 2, with upper and lower spindles sliding in guides in the ejector casing. The valve is operated by means of a cam on the spindle C, which is connected to the driver's controlling handle D. The upper part of the steam valve chamber is in direct communication with the steam pipe whilst the lower part communicates with the large ejector steam nozzle. On placing the driver's handle in the "brake off" position the steam valve is raised off its seating by the cam, and steam is admitted to the large ejector, and quickly restores the vacuum in the train pipe. In this connection it will be noticed that the steam valve is only operated when the controlling handle is moved to the "brake off" position, and no movement of the valve is caused when the driver's handle is moved from the "running" to the "brake on" position. The steam valve is easily removed for inspection and regrinding by unscrewing the cap shown.

The air admission valve B also is of the mushroom pattern. It has top and bottom guide spindles sliding in guides in the casing, and is op-



Section Through Air Admission Valve & Air Back Pressure Valves

Section Through Steam Nozzles and Exhaust Pipe

Section Through Steam and Air Admission Valves.

FIG. 2.

erated by a second cam on the spindle C attached to the driver's handle. The chamber above the air valve is open to the atmosphere, while the under side of the valve communicates directly with the train pipe, communication between the upper and lower chamber being controlled by means of the air valve. When the driver's handle is moved to the "brake on" position the cam shaft revolves and the cam raises the valve, allowing air to enter the train pipe. In the "running" and "brake off" positions the valve remains closed. It will be seen that the valve itself only is raised when the handle is moved from the "running" to the "brake on" position and *vice versa*. At all other times it remains at rest, while the rate of admission of air to the train pipe can be regulated. As the steam and air valve chambers are quite separate, the possibility of condensed steam finding its way into the train pipe is reduced to a minimum. To prevent any leakage of air from the ejector chambers to the train pipe the two back-pressure valves shown in the left-hand drawing in Fig. 2 are provided. The large ejector draws air past both these valves, but the small nozzle draws air only past the lower valve. A release valve may also be fitted by means of which, when the brakes are applied, communication between the small ejector and the train pipe is cut off and the small ejector is set to exhaust the air from the engine vacuum chamber only, thus maintaining a vacuum on the top side of the engine brake cylinder.

With a boiler pressure of 160 lb. per square inch the small nozzle has shown itself capable of creating a vacuum of 26½in. mercury, and with both nozzles in use 28in. have been obtained with the barometer standing at 30in. A drop in the boiler pressure to 100 lb. per square inch made a difference of only about 1½in. vacuum. Against an air leakage equivalent to a ½in. diameter hole, and with steam at a pressure of 150 lb., a vacuum of 20in. can be obtained with the large ejector, and 10in. with the small nozzle.—*The Engineer*, London.

GAS METERS DON'T LIE

"I heard a number of people remark that their gas meters worked overtime when the pressure was low, in fact they were supposed to go at a mile a minute clip whenever there was a gas shortage. I didn't want to pay for something I wasn't getting, so I thought I'd find out if this condition was an actual fact. After studying a while, I worked out this plan. I got up early yesterday morning while the pressure was still good before breakfast-getting time, lighted one burner in my gas heating stove and two in my gas range, turned them on full force, then took out my watch and stood by my gas meter until the hand on the upper dial had made one complete revolution. I made a note of the time required for this.

"Then along about noon when the pressure was 'way down, I repeated the performance—lighted the same three burners, one in my heating stove and two in my range, opened them wide and again did sentinel duty by the meter, watch in hand while the hand on the upper dial made one circumference by the circle.

"I was much surprised to note that it took just about three times as long for the meter hand to traverse the same distance in the second instance when the gas was low as when it was merely normal.

"No," smilingly, "I may yell pretty loudly because I am not getting gas at times, but hereafter I'll not think that the gas people are charging me more or that my gas meter is doing a hundred yard dash when the pressure is low, than when it is normal. And I'm sure that if others tried this simple experiment they'd have the same results that I did."

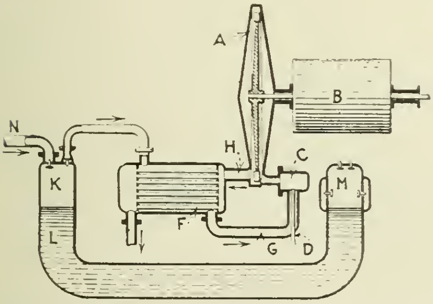
After getting the above story the reporter called on Manager Treleaven, of the local gas company, and asked him if he considered the result of this man's experiment unusual. He replied that it was the only possible result which could have been obtained.

Asked why, in his opinion, there seemed to be such a general belief to the contrary, he stated that it was due to a lack of information on the part of those holding an opposite view.

"There has been a great deal said in times of low pressure," said Mr. Treleaven, "about the meters registering as fast, or even faster, as some would have it, when the pressure was low as under normal conditions. This belief, I think, is merely the result of a failure on the part of those holding this belief to properly inform themselves as to the actual facts. After twenty-five years spent in the gas business, I still have every confidence in the fairness of a great majority of the people—and it has been my experience that where they take a wrong position it is due to lack of information rather than any intention to be unfair, even though the subject of controversy be a gas meter.

"And I might add that if every customer of ours in Topeka would go to his gas meter when the pressure is low and make a note of the time required for the small hand at the top of the dial to make a complete revolution with a certain number of burners wide open, noting down the result, and then at some later time when the pressure was normal, repeat the operation, being careful that the same burners be used, and that they be wide open, I am sure that it would be hard to find anyone who would still hold to the old belief.

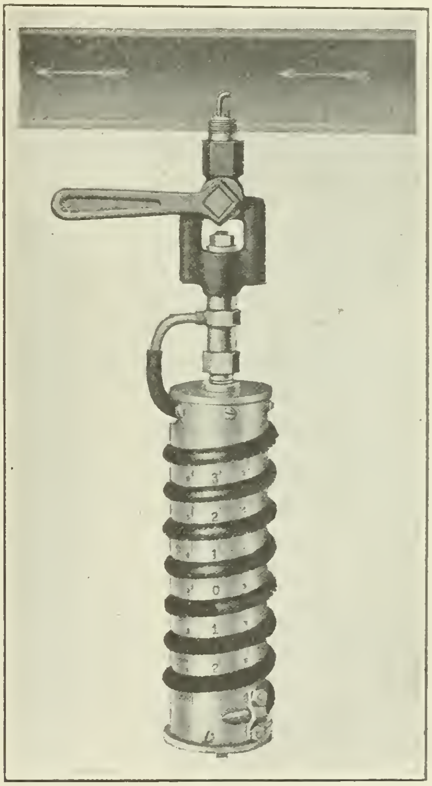
"It would be worth a great deal to our company, not in dollars and cents, but in good will, if all our customers would do this—and I sincerely hope that everyone who might have any intention of raising this question will avail themselves of the opportunity now at hand to find out just what a meter will do under these conditions."—*Topeka Daily Capital.*



COMPRESSED AIR FOR A GAS TURINE

The cut shows the essential features of a gas turbine for which a patent has recently been issued to Brown, Boveri & Co., Baden, Switzerland. In various designs of gas turbines which have preceded this the preliminary compression of air charge for the combustion chamber has been effected by piston or rotating compressors, their employment making the gas turbine as a whole a rather complicated affair In the arrangement here shown the principle of the Humphrey pump is employed for the necessary air compression.

The gas turbine A is directly connected to an electric generator B. The combustion chamber for the drive of the turbine at C, the fuel entering it by the pipe D and the compressed air by the pipe G. The air comes by the pipe N into the chamber K where it is compressed and is then driven into and through the heater F to the pipe G. The water column L connects chamber K with explosion chamber M, the fluctuations of this water column between the chambers effecting the air compression. The exhaust gases from the turbine leave at part H, and flow in a counter-current through the heater F. The sketch is not drawn to scale, the relative sizes of chambers C and M being especially misleading, but the principle of operation will be understood.



A NEW AIR OR GAS METER

The half tone shows a new Pitot meter for air or gas which gives minutely accurate readings of the flow. It is made by the Sargent Steam Meter Company, Chicago. It is quite small and can be attached to any pipe from ½ inch upward, and being light it may be used either as a permanent or a portable instrument.

It consists of a brass tube or well around the periphery of which is spun a semi-circular helical groove in which is wound a transparent celluloid tube the lower end of which connects with the bottom of the well and the upper end with the Pitot tube. When the handle of the cock is in the vertical position the tube is connected with the atmosphere and then oil is poured into the well until it rises in the tube to the zero mark. Then when the lever is turned to the horizontal position as shown, any pressure from the Pitot tube will cause the oil to rise in the tube and as each coil of the tube is about 10 inches the travel of the oil may be read to indications of hundredths of an inch of the level of the oil in the well. Water may be used instead of oil in the instrument. The well and helix are revolvable on the yoke without disturbing the connections so that the reading is always easy. Any error caused by evaporation or condensation is detected upon turning the cock handle for an instant to the vertical position, when the liquid in the helix should return to zero if conditions have not changed. The meters are tested to 100 inches working pressure.

ONE MAN DRILLS FOR LAKE SUPERIOR MINES

In a valuable series of papers now current in *The Engineering and Mining Journal* Mr. Claude T. Rice discourses as follows:

It may be well to discuss the advances that are going to aid in decreasing the cost at these mines where already mining is surprisingly cheap. There can be no doubt that many economies are going to be affected in Lake Superior mining in the near future, as only lately have the companies commenced in earnest to experiment in regard to supplies, types of rock drills and different methods of doing the operations, using trained men to keep track of the experiments so that the latter will show something definite and their outcome will not be a matter of individual opinion, as so often was the case in the past, when the mine captain had the most to say in regard to underground equipment and practice. Probably the greatest economy that is to come in the near future will be due to the introduction of one-man machines in the stopes. The considerable economy in the cost of breaking the ore that will result in their use is assured by tests that have lasted over a year and it is now only a question of getting the men to use them without any friction arising. Some time must be taken to train the miners to their use, as it is no easy thing for one man to run a machine in these stopes that are from 9 to 20 ft. wide, but probably within two years the two-men drills will be the exception instead of the rule in stoping as well as drifting.

NATURAL GAS COMPRESSION

BY E. D. LELAND.*

The first natural gas compressing station in this country was erected in 1880 by Charles E. Hequembourg of Dunkirk, N. Y., one of the pioneer natural gas engineers. This station of 6,000,000 cu. ft. daily capacity was located at Rixford, Pa., and pumped gas to the city of Bradford through 11 miles of 7 in. cast iron pipe. The first compressor installed was a duplex steam-driven machine with 24 in. steam cylinders, 26 in. gas cylinders, and 30 in. stroke. Later three smaller compressors of the same type were added, and all the machines remained in successful operation until that particular field was exhausted.

Later they were moved to Indiana, where we used them in 1891 for testing pipe-lines, and were ultimately sold for compressing air in the coal mines of Illinois. This is certainly a very creditable record for the earliest natural gas compressor in use.

In 1892, at Greentown, Indiana, we completed the first station designed for compressing large quantities of natural gas to extremely high pressures. The problem was to continuously deliver an adequate supply through two eight inch lines 120 mi. long. In 1892, before the completion of the pipe lines, we used the station machinery to compress the gas into large steel tanks under a pressure of 700 lbs. per sq. in., which were shipped to Chicago. The pipe lines when completed were tested at 600 lb. air pressure and the station was designed for these high pressures. The ordinary delivery pressure was somewhat lower, but the compressors proved amply able to compress gas up to the maximum pressure whenever required, and the installation remained in successful operation during the life of the Indiana gas field. In 1898, because of the decline of the gas field, we resorted to compound compression, using eight units for the first compression, and the other four units on the second compression.

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*Superintendent of Compressing Station, Philadelphia Company, Pittsburgh. From Proceedings of the Engineers' Society of Western Pennsylvania, June, 1912.

As the large quantity of natural gas used each day in Chicago rendered storage capacity for a sufficient reserve supply near the city entirely out of the question, it was most essential that a continuous delivery should be maintained by the pipe lines and compressing station. Hence the installation was planned to consist of 12 straight-line, steam-driven compressor units of moderate size, in order that an accident to any one machine would not seriously affect the delivery capacity of the station. The wisdom of this precaution is manifest when one considers that in 1892 we were just entering the then unknown field of high pressure gas compressing work, and, as there was no one who possessed a fund of experience upon which to draw, many features were necessarily experimental, and machinery troubles were to be expected. Later in the history of gas compressing, engineers felt justified in venturing upon larger and fewer units at any particular station. In fact, as early as 1896, the Fort Wayne Gas Company installed some large cross-compound Corliss engines that were used until the practical exhaustion of the Indiana gas field, and were then sold for use in compressing gas in the Ohio and Kansas gas fields, where they are now running and giving good service.

In planning the modern compressing station the principal facts to be considered are the compressors, the motive power, and the general arrangements tending to promote safety and continuous operation. All of these demand attention, for we must consider the station as a unit and realize that any weakness or defect resulting in a shutdown, defeats the purpose for which the station was built and may cause a gas shortage at a critical time.

A gas compressor is practically an air compressor designed to operate under the high pressure usually required in natural gas transportation. The high pressure compressing experience of nearly 20 years ago soon showed the essentials of reliable compressing machinery, and since that time there has existed no necessity for experimenting in order to obtain reliable compressors, nor has there been any valid excuse for a failure to deliver gas on account of defective machinery.

As an instance of what should now be expected in compressor performance I will cite the record of four compressors installed in 1904, and which have been in almost constant operation ever since. They have been steadily compressing gas to pressures ranging from 200 to 275 lb., and are still operating successfully with the original intake and delivery valves that came with the machines. Furthermore, at no time has a shutdown been caused by valve troubles. Such a record leaves little to be desired from the standpoint of reliable service.

Mechanically driven valves of several types have been tried with varying success, but the grit in the gas and other conditions cause trouble, and experience has shown that the smaller poppet-valve is the most reliable type. The compressor cylinders should, of course, be properly water-jacketed, not alone because such jacketing has some effect in cooling the gas during compression, but also because the water keeps the cylinder walls cool and thus helps the lubrication.

For compressing gas in small quantities or for draining nearly exhausted pools, many types and kinds of compressing machinery have been or are in use. We have the standard, straight-line steam engine driven compressor, usually with the ordinary flat steam valve and Meyer cut-off, the type of machine used for years in air compressing work. We have the straight-line two-cycle, and the straight-line four-cycle, gas engine driven compressor. These machines are easy to erect and the foundations not expensive. We have rotary blowers belted to either steam engines or gas engines, and where it is desired to accelerate the flow of low pressure gas in short lines such blowers may serve a useful purpose. They should not, however, be used against a head of over three or four pounds, as above that point the gas leaking back through the blower prevents good results. In some cases the high speed gas engine connected by rope drive to a slower speed and longer stroke compressor, proves a good arrangement. It not only affords relief from the undesirable features of the short-stroke compressor, but it also makes it feasible to locate the engine at a safe distance from the compressor. While the necessarily quick starting of a gas engine is more liable to cause trouble by breaking the ropes or by throwing them out of their grooves, than is the case with the slower starting steam engine, still with this type of plant fairly good results have obtained with either steam or gas engines and with either the English or American rope drive system. But, on the whole, in view of the distance advisable between engine and compressor, the American system is to be preferred.

In fact, at unimportant points, almost any type of compressor will prove good enough for the purpose. But for continuous and reliable service in compressing large quantities of gas, the modern cross-compound Corliss engine, directly connected to the compressing cylinders, makes an ideal installation. This engine is particularly well adapted for the long stroke and moderate speed so engineers thoroughly understand that the changing pressure conditions in field and main lines are also well met by the flexibility and high overload capacity of this type of prime mover. So well is this fact recognized that in the stations delivering gas to the Pittsburgh district we find [illegible]9 Corliss engine driven compressors installed comprising a total maximum capacity of over 76.000 h. p.

A general idea of the varied pressure conditions encountered in compressing gas will be obtained from the following table, showing the range of delivery pressures at the 13 compressing stations of one gas company in the Pittsburgh district, during a day in February, 1912:

Station No.	6 A. M. lb.	9 A. M. lb.	12 M. lb.	3 P. M. lb.	6 P. M. lb.	12 P. M. lb.
1	1¼	1¼	1¾	1	1¼	1¼
2	6	8	9	4	7½	6
3	11	20	15	14	14	15
4	22	21	10½	29	20	18
5	31½	26	20	16¾	16¼	22¼
6	147	128	119	116	116	129
7	155	127	125	122	124	127
8	172	162	152	148	148	148
9	202	210	197	190	189	187
10	250	245	230	224	222	218
11	272	279	275	282	268	262
12	267	280	280	279	275	260
13	325	337	340	335	338	315

Pressures are not only different at different stations, but at each station the intake and delivery pressures are subject to constant change. This occurs from hour to hour and from day to day, and it follows that the horsepower required at any given station varies as these changing conditions influence the ratio of compression. The maximum load occurs at the highest delivery pressure, with the compression ratio at 3:1, or slightly over, and as the ratio changes to above or below this point the work decreases. But, of course, the engine installed must be large enough to carry the peak load, notwithstanding the fact that very few, if any, gas compressing stations operate at their maximum horsepower more than a small proportion of the time.

ST. PAUL AIR LIFT WELLS

The following is abstracted from the report of L. W. Rundlett, superintendent of construction of the Board of Water Commissioners, St. Paul, Minn.

The equipment at St. Paul consists of 6 standard No. 12 Harris 20th Century pumps with 10-in. well taps, adjusting valves and separators giving 733 gal. each per minute; 6 towers 27 ft. to 28 ft. high upon which are mounted 5 by 6 ft. tanks; 1 Ingersoll-Rand, Class O C. compressor with compound steam cylinders, 18 and 34 by 27, compound air cylinders, 18¼ and 30¼ by 27, and 1 500-sq. ft. Wheeler surface condenser and air pump. The plant is installed at the McCarron Lake Station and is intended for summer operation to augment the lake supply.

About a year ago it became evident on account of the unusual conditions of rainfall last year (the total precipitation being a little more than 10 in.), that there was great danger of exhausting our water supply from the lake system, particularly so should the same conditions extend over another year. Means were taken to utilize our lake supply to the fullest extent and after giving careful consideration to available sources for additional supply, it was finally decided to put down a system of artesian wells at the McCarron Lake Pumping Station. The location at this point at the end of the conduit line and at the pumping station seemed the most favorable.

There being no time to make a preliminary boring, a contract was let at once to sink 6 12-in. wells to such depth as might be necessary to obtain a supply of water. Five of these wells were sunk to a depth of 700 ft., and one well to a depth of 1000 ft., in the hopes of increasing the amount of water, but it was found that the increase in depth did not warrant the expenditure in the other wells. The water rose to an average level of about 18 ft. below the surface. A test was made on 2 wells and showed an excellent supply of water, both in quantity and quality. A contract was then let for the pumping plant. Under the existing conditions, it seemed expedient to place a separate unit at each well and to deliver the water through a pipe system to the terminal chamber where it could be used on both high and low service.

Bids were received for installing an air plant or an electric plant, each bidder guaranteeing the efficiency of the plant. Robinson, Cary & Sands Company was awarded the contract for installing an air plant. By the terms of the contract, the addition to the power house for the compressor and an additional boiler were installed by the Board of Water Commissioners. All the physical conditions developed almost exactly in accordance with our anticipations, and the plant is now in successful operation. Under the terms of the test, the Board was to furnish steam to the compressor at 125 lb. pressure. The amount of steam used was determined by the measurement of the condensed water. The heat units of the steam consumed less the heat units of the condensate multiplied by the foot pounds in a pound of steam were to be considered the power furnished. The number of pounds of water pumped multiplied by the height water was raised were to be considered the work done. The amount of work done divided by the power furnished determined the efficiency, which was guaranteed to be not less than 48.3 per cent. with a penalty of $100.00 for every one-tenth of 1 per cent. below this standard and a bonus of $100.00 for every one-tenth above this standard.

The result of the test was as follows:

Duration of test from 8 A. M. to 5 P. M.	9 hours
Average r.p.m. of compressor	80.26
Average steam pressure gage lb. per sq. in.	126.4
Average vacuum referred to 30 in. barometer	26.9 in.
Total pounds of condensed water	35,651
Average temperature of condensate	101.5 deg. F.
B.t.u. per pound of steam at average pressure	1189.7
B.t.u. per pound of condensate	69.1
B.t.u. consumed	1120.6
Average cubic feet water per second over weir 6,350,000 gallons per day	9.78
Average total head in feet	76.83
Total foot pounds water delivered ÷ Total foot pounds steam consumed; efficiency	4.90%
Efficiency covered by contract	4.83%

The test was made using the new 78-in. boiler. No effort was bade to run a boiler test, as it would not figure in the results. The total amount of coal consumed was 4947 lb. This would be equivalent to about 6.6 tons on a 24-hr. run. In starting the test, the first hour 617 lb. were burned on the grate, while the last 2 hr. there was an average of only 344 lb. used. I am very confident that as the firemen become accustomed to the boiler and with careful firing, the plant can be run on 5 tons of coal a day, which, at a cost of $5.00 per ton, would amount to $25.00. I should estimate that $10.00 per day ought to cover all other running expenses, making a total cost of about $35.00 per day. Certainly an excellent showing for the conditions of work.

McCarron Lake Station well plant Air Lifts. In operation from June 12, to November 29, 1911:

Total gallons pumped in 1911	885,528,224
Total pounds coal consumed	1,811,461
Ashes, clinker, etc.	153,395
Total pounds of coal consumed (combustible)	1,658,066
Percentage of ash in coal	8.47%
Gallons pumped per pound of coal (actual)	488.8
Gallons pumped per pound of coal (combustible)	534.4
Average duty in foot pounds per 100 lb. coal	31,445,500

Coal for changing boilers deducted in above.

In the record of the official test run at the McCarron Lake Station in July, 1911, the total lift allowed was the necessary head to flow the water into the receiving basin, or 76.83 ft. the actual lift from the surface of the water in the wells when pumping to point of discharge was 81.725 ft., as shown by record below:

Record Test at St. Paul, Minn., July, 1911

Well Nos.	1	2	3	4	5	6
Diameter in.	10	10	10	10	10	10
Depth ft.	700	1000	700	700	700	700
Static head ft.	19	20	12	20	19	19
Drop ft.	28.6	33.35	41.35	33.35	34.35	34.35
Elevation ft.	30	29	30	29	29	30
Total lift ft.	77.6	82.35	83.35	82.35	82.35	83.35
Submergence ft.	146.4	140.65	140.65	140.65	140.65	140.65
100% ft.	224	223	224	223	223	224

Average lift	81 87 ft.
Average submergence	141 61
Percentage of submergence	63%
R.p.m. Compressor	80.26
Pressure on receiver	72
Indicated horsepower	239.7
Gallons per minute pumped	4401
Theoretical horsepower	90.98
Efficiency	38%

NOTES ON SAND BLAST APPARATUS

BY H. V. HAIGHT

It has recently been my privilege to visit a number of foundries and see several sand-blast plants in operation. A few notes on the equipment, its operation and results may be of interest.

Of the two best rooms seen, one was lined with steel plate, the other with plank. The first used heavy plate, about 12 gage, and was substantial and durable in appearance.

The second room was lined with heavy plank set on end behind cleats. The idea, of course, being that if any of the planks should be cut out by the blast they could easily be removed and replaced by new ones.

There is a great difference in the cleanness of different sand-blast rooms. Some are no more dirty than the average foundry and a visitor, wearing a helmet to protect the head from flying particles, can walk about without discomfort. Others are extremely dusty, the air not only being filled with flying sand, but also with dust and dirt when the blast is in operation, presenting conditions which must be far from healthful.

The second room mentioned above was provided with a slot in the ceiling closed by a door, arranged to allow the crane to drop heavy pieces within the inclosure. In the floor was a grating. The ceiling was made double and there was a bottom exhaust. At this plant the superintendent stated that he changed the workmen every four or five months, believing that long service tends to physical injury. Working for a long period, say five years, in such a place would, he thought, bring on consumption in the case of the average man.

THE USE OF AIR HELMETS

Inquiries were made as to the use of the air helmet; that is, compressed air piped to the helmet worn by the men with the idea that the escaping air will prevent dust from entering. One superintendent recommended the air helmet, although they had never tried it. In another plant these helmets were stated to be objectionable, it being claimed that their use tended to give the operator asthma and head troubles. At still another plant it was said that the hose connection would be so troublesome that the men would not use them. At none of the plants were helmets in use or to be seen.

SAND-BLAST REQUIREMENTS

A common air pressure used in sand blasting is from 40 to 45 lb. per sq. in., although with one system a pressure of 190 lb. is used. A sand consumption of 800 lb. of sand per day of 10 hr. per room was recorded on cleaning steel truck frames and bolster castings. The consumption per casting is about 18½ lb., with an air consumption of 300 cu.ft. of free air per minute per room. At this foundry the fine dust is separated from the sand and the separation seems to be extremely satisfactory. The air is changed 4.87 times per minute with a horsepower expenditure of 7½ hp. per room.

Each room is lighted by incandescent lamps inclosed in wire screens of about 16 mesh.

The nozzles last from one to two days. In another foundry malleable-iron nozzles are used and, while some of these will last as long as three weeks, the cost is about 3c. each.

The sand in most general use was a coarse beach sand. The grains being from 1-32 to 1-16 in. diameter. In the complete systems the sand is automatically returned to the supply hopper, either by a bucket elevator or by fan suction. The dust is also separated from the sand and discharged, often into a standard gondola car. The sand is thus used over and over until it is reduced to a powder with hardly a trace of grit.

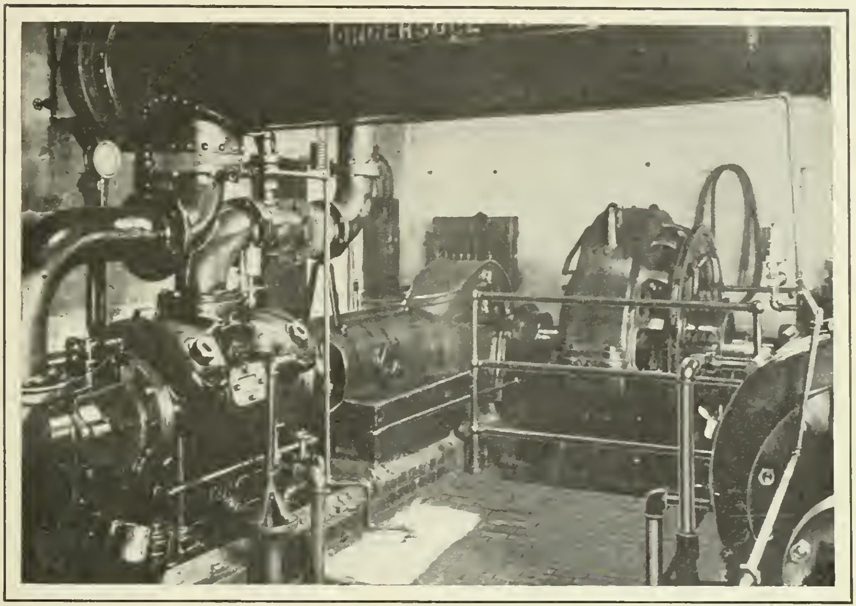
As a general conclusion only complete systems seem successful. All of those which were anything less than complete were intolerably dirty.

USED AS A CLEANING PROCESS

For large work which must be cleaned from sand, as the frames or bases of machines which contain oil for bath or splash lubrication, it seems necessary to use the sand blast as the cleaning process. Where sand burns on, forming a scale, the sand blast seems to be the only practical way to remove positively all the sand.

The above applies to large castings. On the smaller ones the same principle holds, and I believe that the only way to thoroughly remove sand and scale from small castings on which much machine work is to be done is the sand blast. It is true that a cleaning mill pounds down a certain part of the scale and burnishes it, while a sand blast removes scale and has a tendency to show up imperfections. In a general way then the cleaning mill is more suitable for finishing surfaces that are not to be machined and a sand blast for surfaces that are to be finished.

On castings that are to be machined, on automatic and semi-automatic turret lathes, the ideal way would seem to be to first put the casting through the cleaning mill to remove the sand and give a good surface on the parts that are to be left unfinished. Then take it into the sand-blast room and go over the surfaces that are to be machined to remove thoroughly all sand not shaken loose by the cleaning mill and finally blow out all remaining dirt in cored holes and inside pockets. For sand blasting small castings, the best way from the operator's standpoint, is to put them in a sand-blast cleaning mill.—*American Machinist.*



MOTOR-DRIVEN AIR COMPRESSOR UNIT AT THE PARK PLANT OF THE CRUCIBLE STEEL CO. OF AMERICA.

ELECTRICALLY DRIVEN AIR COMPRESSOR FOR SHOP SERVICE

The half tone shows a direct motor driven air compressor installed in the Park works, Pittsburgh, of the Crucible Steel Company of America. It is a two-stage, Class P E 2, compressor of the Ingersoll-Rand Company, with the low pressure cylinder 20¼ in. in diameter and the high pressure 12¼ in., with a common stroke of 18 in. At the rated speed of 180 revolutions per minute the piston displacement is 1,117 cubic feet of free air per minute. Both cylinders have the Hurricane inlet valve and cushioned direct lift discharge valves. The intercooler is set transversely above the air cylinders forming with the vertical pipes a direct connection from the one to the other. The normal delivery pressure is 100 lb. gage, and this is maintained automatically by the governor upon the air intake of the low pressure cylinder.

The air is taken from the compressor to a large air receiver outside the compressor room and from this it is piped to different parts of the works, for hoisting, for operating pneumatic tools, etc.

The motor driving this compressor was manufactured by the Westinghouse Electric & Mfg. Co., and has a capacity of 210 horsepower at 200 revolutions per minute. It is mounted between the high and low pressure sides of the compressor and is designed for operation on direct current circuits at 220 volts. It is of the constant speed type, compound wound, and is equipped with commutating poles. The frame is cast steel and the air spaces are provided in the windings. The motor is controlled by a multiple switch starter mounted on a slate panel. It can be stopped instantly by a push button, which opens the automatic switch or circuit-breaker on the panel. The outfit operates 24 hours a day with the exception of the time between the shifts which is taken for cleaning and inspection.

The commutating poles insure a sparkless commutation at all loads with the brushes remaining at one position. Due to the open type of construction employed, excellent ventilation is assured and air is permitted to reach the windings. The direct-connected compressor results in the saving of power due to the elimination of intermediary transmission.

During the calendar year 1911 the mines on the Witwatersrand gold fields purchased rubber hose for conveying compressed air to rock drills to the value of $334,839.

AN AUTOMATIC ELECTRICALLY OPERATED AIR ADMISSION AND EXHAUST VALVE

BY A. S. WILLIAMSON.*

In the operation of a piece of special apparatus in the mechanical laboratory of the University of Illinois, it is necessary that certain heavily weighted levers be alternately raised and lowered by means of a vertical air cylinder and piston. The flow of air is automatically controlled by an electrically operated valve of somewhat novel design.

An electrically operated unbalanced slide or piston valve requires for its operation considerable force acting through a distance equal to the travel of the valve from admission to exhaust position. If a return spring is used for motion in one direction, this force must be doubled. If poppet valves operated directly by magnets be used, the lifting power of the magnets must exceed the pressure multiplied by the area of the valve seat, and this force must act through a distance equal to the desired lift of the valve. Either design is entirely feasible, but it was desired to avoid the use of powerful solenoids or magnets and the valve shown in the figure was designed to operate with current from one or two dry cells.

In continuous operation, with direct exhaust and consequent quick lowering of the weighted levers referred to, the pipe cap and nipple shown at D, Fig. 1, are removed. The operation is such that, when the electric circuit is open air flows to the cylinders and raises the weighted levers. When, in the operation of the machine, a commutator closes the circuit through the electric bell magnet M, the flow of air is interrupted and the exhaust opened. In the first case, compressed air entering at A raises the plug C, which closes the rubber backed exhaust valve D, and air flows through port FG to the cylinder, raising the weights. Armature P is counterbalanced and as the circuit is open, pin valve N is free to rise and leakage past plug C escapes through port E.

As port C is but 1-16 in. in diameter only a slight external pressure on valve N is required to overcome the air pressure which tends to raise it, and when the circuit is closed by the commutator, magnet M pulls armature P down closing valve N. Air leaking around plug C and passing through choke plug B quickly accumulates over plug C, which drops both by virtue of its weight and of the now unbalanced pressure on valve D. The action is practically instantaneous. The air in the cylinder exhausts through GFD and the plug valve C is then held to a tight seat, since the top area subjected to air pressure is greater than the effective bottom area by an amount equal to the area of the valve seat.

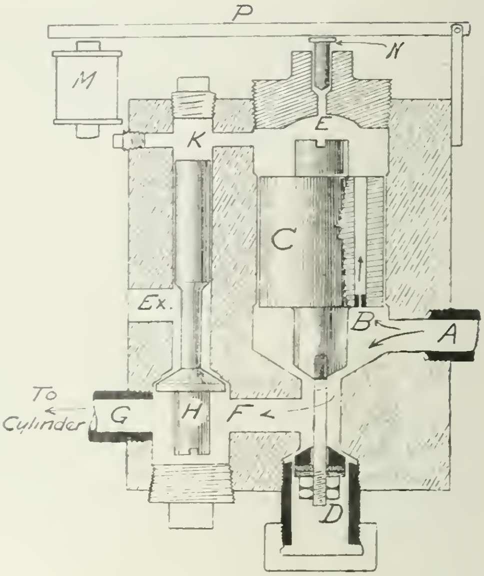


FIG. 1.

In the use of very heavy weights considerable shock results from dropping them suddenly through their free height when the exhaust is opened. This could be obviated by throttling the exhaust, but it is necessary that the weights become quickly effective. When an air passage is throttled, the flow of air as is well known becomes slower and slower as the driving pressure approaches that of the receiver (or, in this case, the atmosphere). It was therefore desired to lower these heavy weights quickly but without any shock due to their fall, until their free height was covered, and then to instantly release the supporting air thus allowing the weights to become quickly effective without the effects of kinetic energy due to their fall. In other words, a throttled exhaust was desired which however should open fully as soon as the weights had become but slightly effective, thus avoiding the delayed effectiveness during the latter part of an entirely throttled exhaust. To accomplish this, leakage is again made of service in two ways.

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*Instructor in Railway Mechanical Engineering, University of Illinois.

In this operation, the cap and nipple at D is replaced. The flow of air to the cylinder is exactly as before, and the air in port F supports valve K, but when the circuit is closed and plug C drops by its own weight, the exhaust cannot take place at D. There is however some leakage past the packing rings of the piston which operates the weights, and this leakage reduces the pressure in F. At the same time the top plug valve H is subjected to full air pressure in K since the magnet has closed valve N. As soon as the pressure in port F has been so reduced by cylinder leakage that its effect on the area of valve H is about equal to the effect of the pressure in K on the lesser area of the upper end of H, valve H drops, and air passes from the cylinder through G and out at the exhaust port marked EX. The areas of valve H and its upper or plug end are so proportioned that exhaust takes place when the reduction of the pressure in F is sufficient to allow the weights to drop gently through their free height. Regulation for different weights is readily effected by adjustment of a reducing valve which supplies the air to A.

Certain important proportions have been omitted until the last since their treatment involves an understanding of the more general operation of the valve. The leakage past plug C and through choke B must be so proportioned to the combined capacity of port E plus leakage past the upper or plug end of H, that when E is closed by the magnet, practically full pressure will accumulate on top of plug C, notwithstanding the leakage around plug H. On the other hand, this leakage around C and through B must be less than the leakage around H plus the capacity of port E in order that when valve N is open the pressure on top of plug C may escape and allow it to lift. This effect was easily secured by making both plugs a close fit to the reamed bores and grinding to a free but close working fit, adjusting the flow of air by means of choke B. The latter is shown for clearness with a drilled hole, whereas it is a solid plug with a tapered flat filed on its side, the plug being driven in until the desired effect was secured by trial.

It will at first appear that the action of the retarded exhaust is slow, whereas in reality it occupies but a fraction of a second, depending upon the pressure used. The diameter of the cylinder is five inches and the capacity of the valve is that of three-eighth inch pipe, a proportion that results in almost instantaneous action.

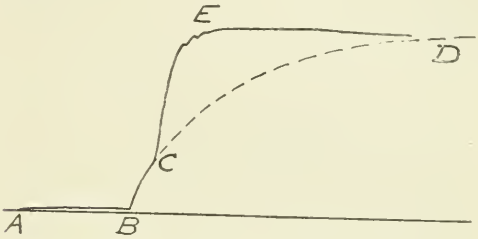


FIG. 2.

Pressure diagrams of the action of the weights (not of the air) exaggerated for clearness are shown in Fig. 2. The effectiveness of the weights is shown as ordinates on a time base. In the figure, when the valve N closes and the supply of air is interrupted, the weights are allowed to lower during the interval of time A-B, becoming slightly effective at B. Here, motion stops but cylinder leakage during a fraction of a second permits effective pressure of the weights to accumulate, and leakage alone would result in the pressure of the weights giving the dotted curve C-D. This slow action however is interrupted at C by the valve H opening and allowing the air pressure to escape, thus permitting the weights to act quickly but without the shock due to a drop through a distance. As stated, the figure is exaggerated. In reality the result is a gentle drop of the weights, without shock, the exhaust appearing to open the instant the weights are at rest, the actual pressure diagram being a steep and almost continuous curve. The valve has been in successful operation for some time and being made of brass is not subject to corrosion from moisture.

ENGINEER'S OPPORTUNITIES

Operating engineers often supply information to consulting engineers relative to their own plants and the latter puts the information obtained into neat typewritten form, and submits it to the employer of the operating engineer: then the latter wonders at the fees charged by the man to whom he gave the information. The prudent operating engineer sends the desired information to his employer direct, thus eliminating the middleman, abolishing the fee system, and collecting what his services are worth. Every time an employer has to seek information relative to his power plant from parties not connected with its operation, the operating engineer overlooks an opportunity to increase his earning capacity. Why should any outsider know more about a given installation than the engineer who is living with it each day? Answer: They don't, if the operating engineer is as big as the job.—*National Engineer.*

AN EARTH MOVEMENT AIR BLAST

Last December, while engaged in the examination of a mine, near Wallace, in the Coeur d'Alene district, Idaho, it was my fortune to experience the shock of an "air blast" and to observe, thereafter its effect on the underground workings of the mine. I am writing the experience with the expectation that some readers of *Mines and Minerals* will be able to describe and explain the phenomenon.

The mine in question is opened by a tunnel and, from a point about one-half mile in from the mouth, a main working shaft 1,800 feet in depth has been sunk. The level on which I was at the time is at a depth of about 2,000 feet from the surface and I was more than 1,500 feet away from the shaft station.

About 3 o'clock in the afternoon, a time when we knew there was no blasting in the mine, we heard a dull, heavy boom, like a distant blast but not preceded by the usual "knock" of shots.

Our lights were blown and we felt the rush of air. Going to a point some distance out in the same drift we met the assistant engineer who was cutting down samples and he stated that he had felt the strong outward rush of air. To him the sound had appeared near, so that his first thought was to go in and see if anything had happened at the face of the drift where miners were working.

Half an hour later, one of the shift bosses came in and stated that the force of air had been strong enough to put out the candles of himself and another man who was with him, knocking the latter down. The apparent explosion, as we learned later, had occurred 200 feet above these men and 400 feet above the level on which my assistants and I were working.

Later we learned that a good many men working in places above and below the level on which the plainest evidence of the earth movement was visible, had experienced about the same shock.

A visit to the level, 400 feet above our working point, showed three broken posts and a pile of dirt 2 feet high along the drift for 2 sets. This dirt had come from the sides, not above, and the lagging overhead was not broken. It was apparently a settlement of a large rock mass, not a giving way of the timbering nor a distortion of the level.

When we left the mine, at the end of shift, I met State Mine Inspector Bell who, with Superintendent Davis, had been at the shaft station on the tunnel level, half a mile underground from the tunnel mouth. Neither of them (nor any one else at that point) had noticed any noise or air movement. However, on going to the mine office, about 300 yards from the tunnel mouth, I was asked by the bookkeeper as to what had hapened. He stated that he had felt the building shaking and rocking in a manner similar to a slight earthquake, but the movement lasted only a few seconds. He also had had a telephone message immediately from another mine office more than a mile away, where about as much of a shock had been felt, and where it was believed at first that it must be an earthquake.—*Mines and Minerals.*

PRODUCTION OF GASOLINE FROM NATURAL GAS

The following is merely the introductory position of a valuable but abstruse article in the September issue of *The Engineering Magazine,* by C. F. Hirschfield, Professor of Gas Power Engineering, Sibley College, Cornell University, and Consulting Engineer in Mining and Mechanical Engineering.

The constantly increasing demand for gasoline, and the difficulty experienced in meeting this demand with the product of the oil refineries lend great interest to any other possible method of producing this commodity. Such an alternative method has acquired considerable prominence during the past few years.

The process referred to results in the production of gasoline from what is called natural gas. By natural gas is meant any combustible gaseous material arising from wells in oil and gas regions. Such gas ranges from "dry" gas, which consists largely of methane, CH_4, and has a specific gravity in the neighborhood of 0.6, to the very heavy vaporous "head casing gas" rising from oil wells. The latter gas often has specific gravity greater than unity as compared with air and contains appreciable quantities of the first seven or eight members of the paraffin series of hydro-carbons, i. e., methane, ethane, propane, butane, etc.

Little, if any, gasoline can be recovered from dry gas; comparatively large quantities can be obtained from the heavier varieties.

The plant required for the recovery of gasoline from gases of this kind is very simple and comparatively inexpensive. It will be shown later that several distinctly different methods might be used, each involving characteristic apparatus. At present, however, there is practically only one method and type of plant in use. This is shown diagrammatically in Figure 1.

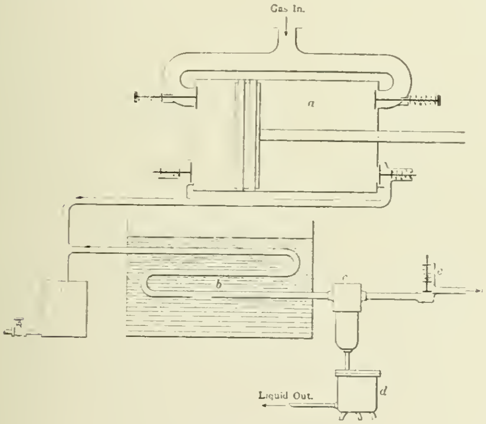


FIG. 1.

In this figure *a* is a compressor, *b* a cooler or condenser, *c* a separator, *d* a trap, and *e* a pressure-regulating or relief valve. In operation, gas is compressed in *a*, cooled at practically constant pressure as it passes through *b*, and the liquid gasoline which results is separated at *c*, from which it drains into the trap *d*. The trap discharges the gasoline into a convenient storage vessel or tank. The gas from which the gasoline has been removed passes through the relief valve to a distributing pipe system or to waste.

It will be observed that this apparatus is merely a simple modification of that used when natural gas is to be prepared for pipe-line transmission. Indeed the process is merely an outgrowth of such preparation. It was often observed that a liquid drained out of natural-gas lines, particularly when the pressure was high and the temperature happened to be low. When investigation showed this liquid to be a high-grade gasoline, little further incentive was required to bring about the perfection and commercialization of the process just described.

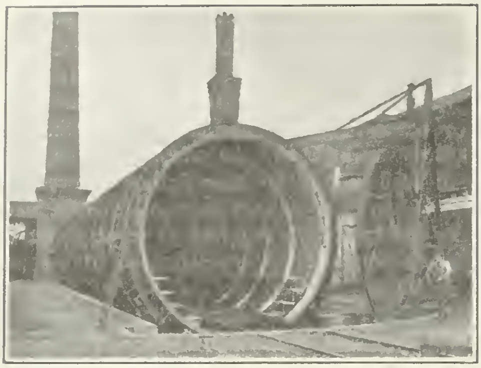
Experience has shown that as many as eight to nine gallons of high-grade cubic feet of heavy gas with specific gravity in the neighborhood of 1.1 referred to air. In general, the possible gasoline recovery decreases as the specific gravity of the gas decreases, becoming practically zero with a specific gravity in the neighborhood of 0.6.

The gasoline made in this way should properly be regarded as a by-product of the gas business and should be manufactured by each producer only to the extent made possible by the sale and utilization of gas. It is however almost unnecessary to state that this is not the actual condition of affairs; owners and operators of gas-producing properties have in many instances continued the manufacture of gasoline in such quantities that they have been compelled to waste large volumes of gas for which there happened to be no market. Such waste of our natural resources has been too well aired of late to require further comment.

NATURAL GAS FOR AN "AIR" LIFT

If you haven't the compressed air handy, and if you have lots of natural gas with a good pressure, and if you want water in a hurry the gas will do the work all right, although it might affect the potability of the water. A writer in the *Practical Engineer* tells as follows how the trick was actually done:

During the recent drouth, our cooling pond got very low and for make up water we pumped from a well near by, with natural gas. Not having an air compressor of sufficient capacity, and the company owning its own gas wells, we lowered 100 ft. of ¾-in. pipe into the well and connected it to the high-pressure gas line. The well being a drilled well 652 ft. deep, 6 in. in diameter and water within 20 ft. of the surface, we were able to get about 100 gal. a minute and kept up the supply until the drouth was broken.



FOR DISINFECTING RAILWAY CARS

The half-tone shows an installation of the Julius Pintsch company, at Hamburg, for the disinfection of cars of the Prussian State railways. The tank is an air tight wrought-iron cylinder, 16.4 ft. in diameter and 75.5 ft. long, firmly fixed on a foundation and provided with rails of standard gage so that it can take inside a railway coach of the ordinary European dimensions. It is provided, as shown, with a rolling door which can be hermetically closed against the open end.

The disinfection is carried on by the combined use of reduced pressure, elevated temperature and the application of a germicide in vapor form. The car is run into the tank and the door hermetically closed. The temperature of the interior is then raised to about 120° F. by means of steam pipes, which line the tank and at the same time pumps exhaust the air to about 27 in. of vacuum. At this temperature and pressure water boils and it is claimed that the combined action of the temperature and pressure causes the death of all vermin. To destroy all bacterial life, some germicide, such as formalin, is then introduced in vapor form from a small tank inside the main tank.

In operation it takes about five hours to effect complete disinfection of the car. One of these tanks has been in operation at Potsdam for some three years and is reported to have given complete satisfaction.

OXYGEN PRODUCTION IN SOUTH AFRICA

Examples of enterprise at the New Transvaal Chemical Co.'s works at Delmore multiply daily. The latest departure is in the direction of providing oxygen at a price and in sufficient quantity to encourage the use in South Africa of the oxygen-acetylene and various related welding processes involving oxygen. It is recognized that the heavy cost of importing oxygen cylinders has considerably handicapped these processes in this country. With this object the New Transvaal Chemical Co. has made arrangements with the British Oxygen Co., Ltd., the owners of the Linde patents, for erecting a large oxygen-making plant of the most modern type at Delmore. The plant will be capable of supplying, at a moderate figure, the whole needs of the Rand, and of South Africa even, in the event of the use of the new-welding process becoming as general as its many admitted merits warrant. The New Transvaal Chemical Co. will also supply the necessary plant and apparatus for the use of the oxygen process in workshops, etc.; and it is expected that this important addition to the Delmore works will be ready in a few months' time.

PROFIT IN REHEATING

The following data give the results of a test made in the shops of the Hansell Elcock Co., Chicago, in driving 1,608 ¾-in. rivets. Half of these rivets were driven using an ordinary air line, and half were driven using heated air from a Sterling Heater. This heater was described and illustrated in our issue of Nov., 1911.

A plain toggle portable yoke riveter was used. The compressor cylinder was 10 ins. in diameter and 9½ in. stroke.

An Excelsior Airometer was put in the line, at which point line pressures and line temperatures were read. Twenty feet of 1-in. rubber hose was used between the airometer and the Sterling heater. On the discharge side of the heater a gage and thermometer were inserted for reading the temperature and pressure of the heated air. Between the heater and the riveter 27½ ft. of 1-in. insulated flexible hose was used. The following shows the results:

	Without heater.	With heater.
Number of rivets	804	804
Ave. temp. of line air.	57.5 deg.	60.0 deg.
Average pressure, lbs..	85	85
Total cu. ft. air used..	14,874	8,513
Ave. temp. of heated air.	...	396 deg.
Cu. ft. air used per rivet	18.5	10.58

This difference in air used per rivet equals 7.92 cu. ft. or an increase in volume of 74.7 per cent. This increase equals an actual saving in air used of 42.7 per cent.

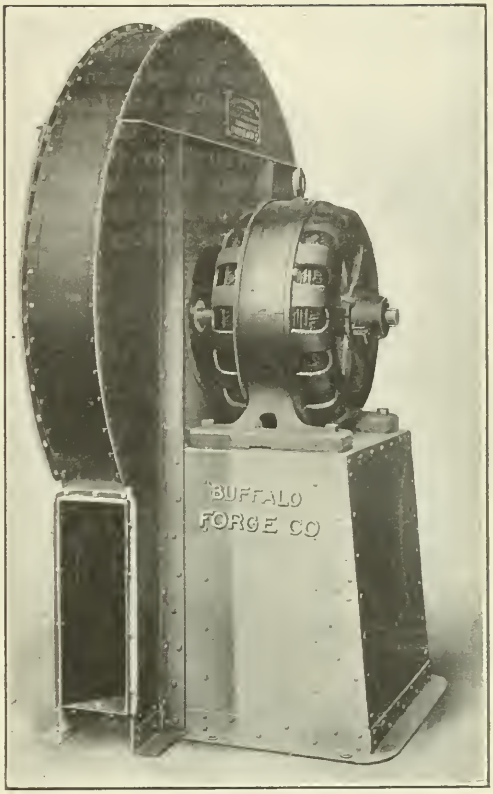
Assuming 1.500 rivets per day, the actual air saving equals 11,880 cu. ft. At 8 cts. per 1,000 cu. ft. this saving equals 95 cts., the cost of operating the heater equals 1 gal. oil at 10 cts. plus 8 cts. for ignition current equals 18 cts., total, a net saving of 77 cts. per day. This saving six days per week would pay for the heater in one year and leave a profit of $156.00.

The cubic feet of air given were actual airometer readings. On account of the intermittent service the heated air temperatures are not quite high enough. The actual temperature of the air supplied to the riveter was about 15 per cent. in excess to the heated air temperatures shown in the table.

The reheater is made by the Sterling Equipment Co., Peoples' Gas Building, Chicago, Ill., who are responsible for the figures here given.

USING AIR BRAKE PUMP EXHAUST

Heating trains with the exhaust steam of the air brake pump is made practicable, it is claimed, by a new device of which the essential feature is a special valve which relieves the back pressure on the air-pump cylinder at the point when the pressure of the air being compressed plus the back pressure is equal to the air pressure in the main reservoir. As long as the pressure of the compressor exhaust is higher than the steam pressure carried in the heating system, the valve will connect the compressor exhaust to the heating system; but as soon as the falling pressure of the compressor exhaust equalizes with the rising pressure in the heating-system reservoir, the special valves automatically operate to cut off the heating system and to open the compressor exhaust to the atmosphere. It is claimed that the operation of this valve is such that very little difference in the back pressure can be noted in the operation of the compressor with the valve and without it, and that 83½ per cent. of the total steam used to operate the compressor can be diverted by this method to the heating system. The valve spoken of is called "Econotherm." and is being put on the market by the Ward Equipment Company, 141 Cedar St., New York City.



ELECTRIC POWER FOR FORCED DRAFT

The half-tone, which, by the way, gives no correct impression as to size, shows a fan and motor installed at the plant of the Merchants' Despatch Transportation Company, East Rochester, N. Y., furnishing air for a large number of oil burning furnaces in the car building and repair shops of the company. The air is delivered at a pressure of 8 ounces per square inch, the oil having a pressure of 5 pounds due to gravity.

The blower is of the steel plate pressure type and has a capacity of 10.000 cubic feet of air per minute up to a pressure of 11 ounces.

The motor is of the constant speed induction type, with a capacity of 75 horse power, and is designed for operation on a three-phase, 60-cycle, 220-volt circuit, with a full load speed of 1.120 revolutions per minute. This rated capacity of the motor is greater than necessary to deliver the above volume of air so that the outfit is actually capable of delivering up to 14.000 cubic feet per minute.

The blower replaced a belted outfit which gave much trouble from the slippage and breakage of belts and which occupied much more room. It has been in operation several months and is giving excellent satisfaction.

The blower is known as No. 10 steel plate pressure type manufactured by the Buffalo Forge Company, and the motor is the well known CCL induction type made by the Westinghouse Electric & Manufacturing Company.

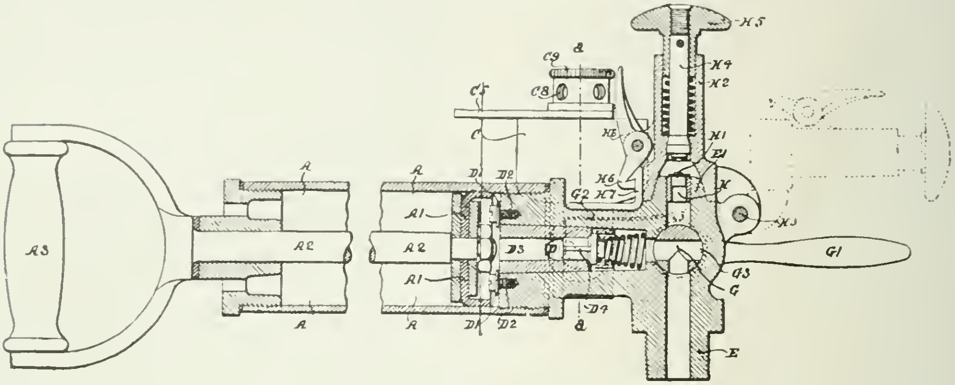


FIG. 1.

A STARTER FOR OIL AND GAS ENGINES

The cut above shows the essential features of an independent starting device for internal combustion engines which is the subject of a recent English patent. The appliance comprises a hand operated air pump the discharge of which is connected, through a passage way in which there may be either a spraying device for liquid or an inlet for gaseous fuel, to a chamber communicating with the engine cylinder isolable from the pump by a valve or cock, and in which there is a detonating device such as a fulminating cap and a hand operated striker therefor. Non-return valves are provided at the fuel inlet and between the pump and detonating chamber, and between the pump detonating chamber and cylinder connexion is a valve or valves such that the pump and the detonating chamber may alternatively be isolated from the cylinder—which latter valve may be so interconnected with the striker as to render the latter inoperative unless the valve is in the position permitting its operation and the discharge of the detonator without damage to the pump and its parts.

Upon operating the pump, air is drawn in through the aperatures C^8, fuel through the aperatures C^6, C^3. Their proportions and amounts are regulable by adjustment of the cap C^9 and handle C^5 respectively. In operation, the piston of the engine being at the commencement of a firing stroke, and the device being coupled to its cylinder by the arm E, the cock G is positioned to open communication between pump and cylinder, and the pump is operated until an adequate starting charge of mixture has been injected into the cylinder (to this end a pressure gauge may be applied to the cylinder arm E or axially to the cock G). The cock G is then moved to close connexion to the pump and open connexion between cylinder and detonating chamber, a cap having first been placed in position therein. The cap is then detonated by operation of the striking plunger H^4, so firing the charge and starting the engine.

Thorlakhavn, the best natural harbor on the south coast of Iceland, has been acquired by a French company, along with neighboring waterfalls yielding about 200,000 horse-power, and a plant will be erected at this place for manufacturing artificial saltpeter by the utilization of atmospheric nitrogen, according to the Birkeland-Eyde process.

In drilling for gas or oil in Fayette county Pa., recently, the Wharton Oil & Gas Company penetrated 29 feet of coal in sinking a well 530 feet in Wharton township. In drilling the well one three-foot, one five-foot, two six-foot, and one nine-foot veins of coal were drilled through.

METHODS AND COSTS OF APPLYING STUCCO WITH "CEMENT GUN"

BY R. C. HARDMAN*

The writer recently has had occasion to use the "cement gun" for placing stucco on the exterior of a small frame building, containing 631 sq. yd. of surface and having 56 door and window openings. He gives below the methods and cost of doing the work.

The building, which is two stories high, consisted of a main front with two rear wings, in the space between which the gun was stationed, with the sand and cement storages immediately behind. The typical force in the operation of the gun was one man running the engine and gun, two men mixing and sacking dry material and charging hopper, one nozzleman, one laborer to help nozzleman, and two laborers cleaning grounds and screeding.

The entire building was first covered with cheese-cloth, then with a cheap grade of building paper secured by laths running vertically on the studs. This was then covered with mesh reinforcement secured by 1½-in. staples. Grounds were placed on alternate studs to give a stucco thickness of 1¼ in. The panels thus formed were filled alternately to within about ¼ in. of the face of the grounds. The grounds were then cleaned off with a small trowel and about thirty minutes later the stucco was brought flush with their face and screeded off. The screeding was done by unskilled Mexican labor with a straight-edge shod with steel. When these panels were set, the grounds were removed and the panels between were filled in the same way. The work was done in four sections vertically. The top section was done first so that falling material might find a lodging place below. When a section was completed it was lightly sprayed to secure uniform color and cover up joints. The mixture used throughout was one part of portland cement to three parts of sand.

In shooting the mixture onto the wall the nozzleman stood so that the nozzle was from three to four feet from the wall, and kept the nozzle in continual motion so as not to pile up too much mortar in one place. In accordance with the principle of the device, the dry mixture was mixed with water at the nozzle. The amount of water used was just enough to keep the mortar below the running point. Water was delivered at about 40 lb. pressure. The air pressure used was 26 lb. A higher pressure than this caused too much waste of material (mostly sand) by rebounding, and a lower pressure tended to clog the hose with dry material.

The apparatus consisted essentially of an engine, an air compressor and the "cement gun," which is a hopper, having a caisson lock, for receiving the dry material and from which it is forced through a hose to the surface to be covered. As used the outfit comprised a 4-cycle, 4-cylinder gasoline engine, connected to a 2-cylinder single-acting air compressor by means of belt and pulley operated by a belt tightener. On the front of the engine and operated by its flywheel was a small water pump for the engine water-cooling system. A second water pump attached to the compressor and operated by its flywheel was available for pumping water to the hose nozzle. Neither of these pumps was used, as the water pressure from the mains was sufficient.

Connected to the air compressor was the hopper or "cement gun" proper. This consisted of two connected air chambers—upper and lower—each closed at its top by a flap valve hinged to swing downward by gravity and closed by outside levers. The feeding mechanism, which consisted of a revolving slotted wheel, was at the bottom of the lower chamber and allowed the dry mixture to fall through and be forced through a hose, at the nozzle of which it was mixed with the proper amount of water.

In operation the lower chamber was first closed by its valve and filled with air. The dry mixture, which previously had been sacked for convenience, was put into the upper chamber, the upper valve closed and the air turned in. As soon as the pressure in the upper chamber equaled that in the lower the valve connecting the two chambers opened by gravity, allowing the dry mixture to fall into the lower chamber where the revolving slotted wheel allowed it to feed through into the hose connected to the bottom of the lower chamber under the feed wheel. When sufficient material had been forced from the lower chamber to allow its valve to be closed, the exhaust from the upper chamber was opened and the pressure reduced until the lower valve was held closed by the pressure in the lower chamber.

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*Civil Engineer and Superintendent of Construction, U. S. War Dept., Fort Huachuca, Ariz.

The upper chamber was then again filled with the dry mixture, so that the feeding and discharge through the hose was continuous and uniform.

The feeding mechanism was operated by a paper wheel and friction disk controlled by a lever. The dry mixture passed through the feed wheel into the hose and was then picked up by the air directly from the compressor and forced through the hose. The hose used was a 2-in. steam hose.

TABLE SHOWING COST OF STUCCOING 631 SQ. YD. OF SURFACE WITH CEMENT GUN

		Cost	Cost per Sq.Yd.
Material for Lathing.			
Cheese cloth 631 sq.yd. at	$0 035	$22.9	
Building paper 56 8 squares at	0.30	17.04	
Wire, 631 sq. yd. at ..	0.1278	80.64	
Lath, 500 sq.yd. at....	5.25M	2.63	
Nails, 10 lb. at	0 04	0.40	
Staples, 200 lb at.	0.0425	8.50	
		$131.30	$0.2081
Labor for Lathing:			
Carpenters. 16 hrs at	$0.5625	$ 9.00	
Carpenters... 59 " "	0.50	29.50	
Carpenter helpers.... 144 " "	0.375	54 00	
Laborers. 33 " "	0.218	7.22	
Laborers:Mex;41 5" "	0.156	6.49	
		$106.21	$0.1683
Total for Lathing		$237 51	$0.3764
Material for Plastering:			
Portland Cement 65 bbl. at	$3.43	$222.95	
Sand (at site).....			
		$222.95	$0.3533
Labor for plastering:			
Nozzleman... 96 hrs. at	$0.5625	$54.00	
Engineer.....100 " "	0.375	37.50	
Laborers, mixing... ... 212 " "	0.156	33.13	
Laborers on wall... 156 " "	0.166	26.00	
Laborer (hose).59 " "	0.218	12.94	
		$163.57	$0.2592
Fuel:			
Gasoline; 97 5 gal. at	$0.22	$21.45	
Lubricants.		4.90	
		$ 26.35	$0.0418
Total for plastering.....		$412.87	$0.6543
Total...		$650.38	$1.0307

Time: 12 days.
AVERAGE: 52.51 sq. yd. per day

The resulting cost per square yard appears rather high, but it must be remembered that the stucco is 1¼ in. thick (the average thickness is somewhat more owing to the stretching of the cloth between studding), the cement is high in cost, and efficient labor difficult to secure. The nozzleman was an experienced man, but all other labor was unfamiliar with the work.—*Engineering News.*

MINE GASES

White damp is the gas most feared by the miners, for its properties render it difficult to detect, inasmuch as it is tasteless, odorless, and colorless, and when mixed in the proportion of about one part of gas to nine parts air is called "fire damp," and becomes explosive to a degree hard to realise unless one has seen its effects. Black damp, unlike white damp, is heavier than air, and is a non-explosive gas which may be detected by its peculiar odor. Again, unlike the other, its effect is to suffocate and extinguish fire. This gas is so heavy and moves with such a sluggish flow, that occasionally when miners have been trapped in a mine following an explosion, and have detected the black damp creeping in on them by its smell, they have been able to stop its advance by erecting dams or barricades along the floor, building them higher as the volume of gas increased, and keeping the air within their little enclosure comparatively clean by rude, improvised fans. Following an explosion, these two gases become mingled, and form a mixed gas possessing all the dread qualities of each, which is known as "after damp," and it is this mixture of gases which destroys any life that may remain following a mine disaster.

AN AIR CUSHION AUTO

The air cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine Works in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

It is claimed for the new invention that it is adaptable to all kinds of roads, regardless of speed or weight of machine; that the air cushions work instantaneously with softness and ease of movement; that there is an entire absence of vibration, as no metal springs intervene between the axle and the car body; that there is almost perfect balance in rounding curves; and that there is as nearly perfect working safety as can be secured. The machine has been undergoing severe tests for several months, having already run more than 4,300 miles over unfavorable roads.

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COMPRESSED AIR TRANSFORMS THE TRADES

It is not easy to realize how completely some of the more prominent and important of the mechanical trades have been transformed by the general adoption of compressed air operated apparatus. We are thinking here of the workman in the shop, of the change in the demands upon his individual strength and skill and of the difference in both the quality and the quantity of his output which has followed the incoming of the modern methods and facilities, especially the pneumatic devices.

Tools and apparatus operated by compressed air have not only relieved the workman from the exhausting physical exertion which was required all through the trades, and which brought premature old age if the occupation was constantly followed, but have actually superseded and surpassed the slowly developed skill of manipulation of the workman of the olden time. It is idle to regret the decadence and the disappearance of the skill which there is no longer any use for. The earning power of the workman has not been reduced in consequence. He gets as much on the average as he ever did, and he gets it easier and in fewer hours, and where he does not it is not compressed air or electricity or any other of our latter day alleviators of toil which are to be blamed for it.

It is quite commonly thought that the trade of the boilermaker has been more completely transformed than any other, since once its operations were almost exclusively manual and depended upon highly developed skill in the workman, while now there is little or nothing in the boiler shop which is not done, and better and more quickly done, by air operated tools, but in fact the transformation of the molder's trade has been almost as complete, while foundries and their operatives are much more numerous.

Mr. W. H. Armstrong in a recent address before the New England Foundrymen's Association at Boston, which is altogether too long for reproduction in our pages, mentioned in succession, with brief remarks upon the function of each, the various types of air operated devices which now are employed in every up-to-date foundry, and without which it is not too much to say that no foundry can be successfully operated.

A foundry needs an air compressor almost as much as it needs a cupola, and proper thought should be given to its selection and installation and operation so that the air in volume and pressure may be always ready wherever it is needed throughout the plant.

The most extensively distributed line of apparatus, but by no means entailing the greatest consumption of air, will be the air hoists. The single cylinder direct vertical hoist is one of the simplest of devices and perhaps the most serviceable of all, while the geared motor hoist has also its special line of applicability, and the motor applied to the geared crane does the heavy work. These hoists are all used intermittently, and there is no charge against them for air except for the little time when it is actually in use. Hoisting is an operation constantly occuring in the foundry and in the molding work air doubly supersedes hand lifting in that when a thing is hoisted, as for instance a cope which has been rammed, it is not necessary to set it down anywhere, but it can be held suspended and turned over for examination or for retouching and finishing in the most convenient position, and when all is ready the mold can be closed as gently and safely as could possibly be required.

Ramming sand was the molders hard work all day, and the carrying of the heavy ladles closed his labors, but now he is relieved of both; of the latter by the hoisting and conveying devices, and of the former by the various types of sand rammers, little and big, and the molding machines, first the squeezers and now the jolting machines, one or the other, as best adapted for the special job, packing the sand with just the required firmness and with the repetitive precision which human hands could never equal.

Then there are the chipping hammers and the various sand blast arrangements for cleaning the casting, and other minor employments for the air, all lightening the molders' task and greatly increasing his efficiency thereby.

Much more might have been made of the Rip Van Winkle legend than Irving ever dreamed of. He should have been a mechanic and he should have lived a century later. The time is ripe for another Rip to wake up, and he might as well be a molder.

A TUNNEL ENGINEER DIES

The hazards of engineering are not spectacular and the risks the engineer must run are not of a kind which thrill the reader. Yet they demand their toll of life like all other risks, and while that toll is generally levied on the young men of the engineering rank and file it must sometimes be paid by eminent men like Charles L. Harrison, who passed away on Sept. 15 as a result of devotion to his duty as assistant chief engineer of the East River division of the Pennsylvania terminal improvements in New York. It is only recently that his marked ability as an engineer came to be recognized by the profession generally, for he said very little and wrote less about his own work. But he nevertheless had a large circle of influential friends, with whom he spent his leisure hours, and his standing among them was shown by unusual proofs of reliance in his integrity which need not be narrated here. When the construction of the East River tunnels was begun he realized that the compressed air work would present some danger to a man of his physique, but he accepted the risk, and when, just at the end of the work, he fell a victim to too rapid decompression, no complaint escaped him. For four years he lived a very quiet life, and his many friends lately rejoiced at an apparent improvement in his health. But it was only apparent, for his weakened heart was unable to carry him through the strain of a hard cold. There are many engineers who will think of the loss the engineering profession has sustained whenever they use the tunnel between Manhattan and Long Island City, and his influence will be felt for many years through the effect of his fine example on the young men under him.—*Engineering Record.*

COMPRESSED AIR CHURNING

In our list of patents for July 30, we unfortunately omitted No. 1,034,350, to Alpheus Fay, Louisville, Ky., covering an improved churning process. It provides for the production of violent ebullition in a volume of milk by the "tangential collision" of two jets of air, the containing vessel having unobstructed concave walls. The ebullition is produced for a period of from 30 to 60 seconds. If the churning process is made as short as that it will be a revolution indeed, and may lead to important changes in dairy practice; and of course every dairy will want a compressor.

UNDERGROUND TEMPERATURES AND WORKING CONDITIONS

The New Zealand Mine Commissioners say in the course of a recent report that in deep metal mining it is sometimes necessary to circulate a larger volume of air than is required to produce, from a quality standpoint alone, adequate ventilation. For the purpose of reducing the temperature of the rock-surfaces a greater volume of air is necessary, for if this were not effected hard work would be either intermittent or unbearable in the heated atmosphere of many deep and hot mines. Observations made with the object of determining the rate of increment of temperature with depth in several countries where deep mining is conducted have shown considerable divergence in different places, as will be seen from the following comparisons of the results of temperature observations:

Locality.	Depth required for an increase of 1° F. Feet.
Comstock, U. S. A.	33
Witwatersrand, Transvaal	208
British Colliers (mean)	64
Bendigo, Victoria	77
Ballarat, Victoria	80
Thames, New Zealand	43.5
Waihi, New Zealand (approximate.)	32.8

The relative rock-temperatures at the 1,000 feet level at Thames and at Comstock are 83 degrees Fahr., and at Waihi approximately 85 degrees Fahr., but it was fond that, owing to various causes, the temperature throughout the Waihi Goldfield at any particular horizon was by no means constant. During the investigations the Commissioners found that the air in the working-places at Waihi and Thames was highly saturated, generally to the extent of 90 per cent. or more, and that the wet-bulb temperature of the air in working-places ranged between the following limits at the deepest levels:

	Underground. (Wet Bulb).	Outside in Shade (Dry Bulb).
Thames Goldfield (1,000 ft. level)	70.0° to 83.5°	55.0°
Waihi Mine (1,000 ft. level)	61.0° to 82.5°	56.5°
Waihi Grand Junction Mine (944 ft. level)	64.5° to 83.0°	55.0°
Waihi Extended Mine (960 ft. level)	79.5° to 89.0°	50.0°

On the Reefton Goldfield the rock-temperatures are not nearly so great, the highest temperature recorded,—viz., 78° Fahr., wet bulb—being obtained at the 1,266 ft. level in the Progress Mine. To reduce excessive temperature and to cause an appreciable current to circulate through the heated stopes of the mines, an increased volume of air is necessary, but the extent to which underground temperature may be reduced by this means is somewhat limited, as our investigations have proved. The rate of increase in temperature of the outside air when conveyed into deep mines is demonstrated by the following measurements taken by us. During our inspection of the Thames mines we ascertained by actual measurement that atmospheric air which entered a Root blower at the surface, and was forced at a velocity of 10 feet per second through a thin galvanised-iron 22 in. air-pipe down a vertical shaft 1,000 feet in depth, and along a crosscut 670 feet in length, increased in temperature in the space of 2 minutes 47 seconds from 55° to 76° Fahr., being at the rate of 7.64° Fahr. increase per minute. The temperature of the air surrounding the pipe did not exceed 81° Fahr. At the Waihi-Grand Junction Mine we found that the temperature of the air, while passing from the top to the bottom of a vertical downcast shaft 955 feet in depth, increased at the time of measurements from 51° to 56° Fahr., the velocity of the air being at the rate of 16 feet per second. In this case the temperature of the air in the shaft increased at the rate of 5° Fahr. per minute. The return air in the fan passage at the surface of this mine was 69° Fahr. (completely saturated). From the foregoing examples it will be noted that in the North Island of New Zealand, where the outside temperature is equable (the mean surface temperature at Waihi being 55.7° Fahr.), the temperature of the air descending into the mine will have attained that of the rock-surfaces within seven minutes of entering the shaft. In discussing the effect of high temperatures on miners, the British Royal Commission on Mines (1909) reported as follows: "The influence of high temperatures on men is intimately dependent on the moisture in the air, and also on its motion, for the greater the dryness of the air and the greater its motion the more rapidly does warm air carry off the heat of the body and thus neutralise the ill-effect of the heat. The existing evidence indicates that in still and saturated air continuous hard work is practically impossible at temperatures exceeding about 80° Fahr., even when men are stripped to the waist, and that when the air-temperature is higher than this the result is the same if the wet bulb temperature rises about 80° Fahr. A temperature of 100° or 110° Fahr., with the air so dry that the wet-bulb temperature is only 80°, is thus no worse than air completely saturated with moisture at 80° Fahr. In other words, it is the wet-bulb temperature, and not the actual temperature of the air, that matters to a man when the air-temperature is high. In moving air, however, a somewhat higher wet-bulb temperature can be borne than in still air. At wet-bulb temperatures exceeding about 80° Fahr., the amount of continuous work which a man is capable of doing without serious rise of bodily temperature rapidly falls off and becomes practically nothing at 90° wet bulb."

The report adds:—"As a result of our investigations and deductions from the foregoing evidence, we are of opinion that, to secure a continuous distribution of the air in metal-mines adequate to reduce the temperature in hot working-places within reasonable limits, a standard or fixed temperature of 80° Fahr., wet bulb, should not be exceeded, unless it is not reasonably practicable to maintain the air at such standard, in which case a reduction of the hours of employment should be provided for.

AN OIL AND COMPRESSED OXYGEN EXPLOSION

A severe explosion in connection with the starting up of a Diesel engine occurred recently at Bray, Ireland, and it carries a lesson which should be heeded. The circumstances of the accident are presented clearly in the report of the matter by Mr. D. E. McDonnell, the assistant electrical engineer, who wrote as follows:—

"On Sunday, the 7th inst. (July), the starting air of the Diesel was lost, and, following the instructions of the engine builders, Mr. Sowter sent to Dublin for a 40 ft. cylinder of oxygen. On the 10th we charged the blast receiver from this cylinder, raising the pressure from 350 lb. to 700 lb., and also passed a little into one of the starting receivers; the pressure in the latter was about 350 lb.

"I started up the engine in the usual manner, and, going on to platform, put the starting lever into the running position. The engine did not appear to be running properly, but before I could discover what was wrong the fuel valve on the cylinder cover of the engine exploded; the flame from this burst along the blast pipe, reaching the blast receiver, which then also exploded.

"I attach copy of the paragraph from the makers instruction-book which relates to the use of oxygen. From this you will see that we had every reason to believe that there was nothing hazardous nor very unusual in using this gas:—'If by any mishap the air is lost, and no compressor is available, or if the engine cannot be run by external means so as to charge the receivers with its own compressor, then these may be charged with carbonic acid gas or oxygen from cylinders containing these compressed gases, as used for many purposes.'

"In the ordinary course of events there would be no explosive mixture in these receivers, and I consider that there is no danger of a repetition of such an explosion. Personally, I will have quite as much confidence in the Diesel engine as I had before the accident."

The *Electrical Review* has, by inquiries, elicited the fact that the connection from the blast receiver to the fuel valve of the engine consists of about 14 ft. of 3-8 in. bare copper tube. Crude Texas oil fuel has been used since the engine was installed, about 2½ years ago. No other quality has been used except to start the engine, should she have been lying off for any time, or have been dismantled when ordinary paraffin oil (kerosene) is used.

More than one authority has investigated and reported upon the accident, the chief engineer of the National Boiler and General Insurance Co., stating that the accident was not in any way due to defective design or construction of the engine or of the air receivers, but was owing solely to the use of oxygen for raising the pressure in the latter.

The Bray Council engaged Dr. Lilly, of Trinity College, and Mr. William Ross, M. I. M. E., of the firm of Ross and Walpole, Engineers, Dublin, to report on the accident, and the following are pertinent extracts from their report:—

"We find that the explosion in the Diesel engine was due to the use of pure oxygen instead of air. The builders of the engine were cognizant of the fact that oxygen was being used for starting the engine, as stated in your engineer's letter to them of February 15th, 1912. It appears that the use of oxygen for such a purpose in engines of this kind is dangerous. This explosion resulted from its use.

"The condition of the engine and wreckage points to the conclusion that the explosion was caused by the presence of the oxygen with fuel, somewhat in the following manner:—

"Near the completion of the compression stroke of the engine, the compressed air being charged with oxygen and fuel, exploded in the engine cylinder, with a rise of pressure far above that obtained under the usual working conditions with air. This pressure exceeded that in the air injection cylinder and pipe connected to the fuel valve; the flame from the engine cylinder ignited the mixture, and caused the explosion to be transmitted through the connecting pipe to the air-infection cylinder.

"The condition of the wreckage of the air-injection cylinder indicated that the explosion was instantaneous, and gave rise to enormous pressure. This was probably due to a rich mixture of nearly pure oxygen and oil vapour in the cylinder."

That reputable builders could ever have put themselves upon record as recommending or even permitting the use of oxygen in this way would seem to be one of these cases where truth is stranger than fiction. The occurrence points the way to the more universal installation of air compressors with small gas or oil engines to drive them.

NOTES

A recent German patent covers an arrangement for the preservation of oil paintings by the use of nitrogen. An air tight case with a glass front encloses the entire painting and the space is filled with nitrogen.

A bill has been presented in the House of Representatives which provides for the establishment of a Bureau of Farm Power, in the Department of Agriculture. The province of the bureau would be to investigate and report on all matters pertaining to methods of furnishing power on farms, and all labor-saving machines in agriculture.

The following was found on the bulletin board where machine runners mark up their troubles, at a certain coal mine: "No. 4 Masheen awl Shot tu hel. Chain brok. fix the dam thing. it brok twist Last nite. needs new rearstaff leaver for the resisting box. amatoor smokes like heltoo. Power bad. lots of short circles. this is the masheen with self compeller truck. Wer outa oil tu."

At a recent agricultural show in France acetylene lamps were exhibited designed for attracting and destroying moths of harmful species, and more especially cochylis, one of the vine's especial enemies. A less laudable use of acetylene lighting has been the employment of acetylene lanterns by certain "sportsmen" with the object of attracting game, and it has now been decided in France that such aids to increasing the "bag" are illegal.

In the report of the medical inspectors of factories in Illinois one plant is cited which had 73 cases of lead poisoning last August, due to dry sand-papering of lead paint. With the use of a simple respirator for the protection of these workers as recommended by the department, the hazard of this occupation has been so far reduced that there has not been a single case of lead poisoning in that particular establishment in the last four months.

An English paper makes the statement that forty firms are building turbines in England, 20 building marine turbines exclusively. Of the marine turbines built, all but two are of the reaction type; but of the land turbines about 14 are impulse machines of various designs. At least two firms are specializing in small turbines. On the Continent there also appear to be 40 firms known to build turbines. About eight are reaction turbines and the remainder impulse.

An explosion and fire at the plant of the Sun Oil Co., Toledo, Ohio, caused the death of one employee and the injury of three others. According to reports the accident was due to escaping gas, from a tank-car of gasoline, coming in contact with a fire in the boiler room, 75 ft. away. After the explosion, the flames jumped back to the car of gasoline and to a still containing gas, and the latter also exploded, scattering debris around the plant and adjacent property.

A machine combining two modern inventions, the electric car and the vacuum cleaning apparatus, has been applied in Strassburg to clean the tramway tracks of that city. In the operation of the machine the roadbed is sprayed with water, then the dirt is loosened by a scratcher and drawn up into the car by the suction apparatus. With this machine one man can clean 25 miles of track a day, replacing the labor of 17 men working in the ordinary way.

The Bureau of Gas and Electricity of New York City reports to the Public Service Commission that during August it tested 28,509 gas meters, of which 3,773 were new meters, 24,603 were repaired and removed meters, and 133 were tested on complaint. The law allows a deviation by gas meters of 2 per cent. in either direction from absolute accuracy, and of the meters tested on complaint 53.5 per cent. came within this limit, 12.6 per cent. were more than 2 per cent. slow and 33.9 per cent. were more than 2 per cent. fast.

A good deal has been recently heard about "holes in the air" in connection with sudden collapses of flying machines. Prof. W. J. Humphreys, of the Washington Weather Bureau, writing in the *Popular Science Monthly* classifies the eight different types of atmospheric disturbance as follows:—A vertical group, including aerial fountains, aerial cataracts, aerial cascades, and aerial breakers, and a horizantal group, including wind layers, wind billows, and aerial torrents; in addition, wind eddies fall under both groups. Holes in the sense of vacuous regions do not exist.

Preheating air for internal combustion engines was recently discussed in Le Génie Civil by A. Nougier. The author recommended passing the air over tubes in a preheater taking much the same form as a tubular boiler, the exhaust products from the engine cylinder passing in the reverse direction through the tubes. He claimed that it is possible to construct a heater capable of preheating the air to 175 deg. Fah. at no load without overheating the air at full load. Such a heater for a 200 horse-power motor would be 23 inches in diameter and contain 100 tubes about 40 inches long.

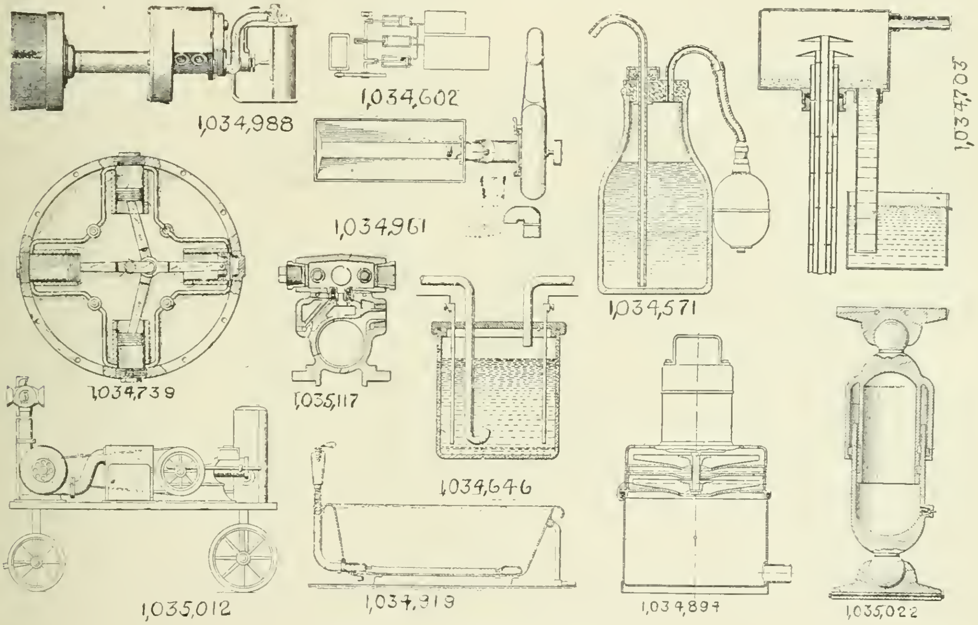
Ventilation by individual air ducts has been tried at one of the public schools in Minneapolis under the direction of the engineering division of the Minnesota State Board of Health. The air was discharged through individual funnel ventilators placed beside each desk. It was found in experiments extending over a period of four weeks that satisfactory ventilation could be maintained in this way by supplying only 8 cu. ft. of air per minute per pupil as compared with 30 cu. ft. required under the ordinary fan system of ventilation.

Fifty-eight miles an hour, attained by the hydroplane "Tech, Jr.," in speed trials on Huntington Bay, Sept. 5, makes a new record for fast speed on the water. The boat is 20 ft. long and has a beam of 7 ft., and her hull below the water line is flat. She was built by Adolph Apel, at Vintnor, N. J., and is driven by an eight-cylinder Sterling engine of 150 hp. When traveling at high speed, the boat is out of the water, from a half to two-thirds of her length, a large part of the time.

The Engineer, London, describes as a German invention and the subject of a recent German patent what we in the United States are already quite familiar with as the Cement Gun. A detail of the German patent spoken of covers the use of compressed carbonic acid gas instead of air to hasten the setting of the mortar. This might work, but would be far too costly on account of the quantity of gas required.

There has just been put out of service at the Dolcoath Mine an engine which was erected in the year 1815. During all the intervening period it has been working faithfully and well and is a tribute alike to Cornish mechanical genius and workmanship. That it has now ceased to perform its functions is due to no sense of lack of duty or weariness in well-doing, but simply to the circumstance that the old at Dolcoath is giving place to the new. So it comes to pass that this fine old piece of mechanism, when still capable of service, is put out of commission. We do not know if it is the habit of Dolcoath to "pension off" its discarded machinery, but if ever "5s. a week" were deserved surely it is by this old engine which has served the mine since the year when Wellington won the battle of Waterloo.—*Mining World*, London.

There is a somewhat remarkable man in the employment of Messrs. Holman Bros., Ltd., the widely celebrated firm of engineers at Camborne. His name is Henry Veal, and he is 86 years of age, having been born in the year 1826. He was working in the pneumatic air cushion shop on Tuesday week with as much diligence as any of his younger confrères. For 43 years he has been thus employed, and according to all appearances is likely to complete his half century, or more. He has always refused to take any holiday.—*Mining World*, London.



Pneumatic Patents, August 6.

The new railway that will pass through the Loetschberg tunnel, in the Bernese Alps, is protected from avalanches by great fortifications. At the southern entrance to the nine-mile-long tunnel a massive stone wall has been built, 30 feet high, and seven or eight feet thick at the base. Behind and above this wall is a kind of trough. When a descending avalanche strikes this depresssion it will be diverted upward, and clearing the railway below in a parabolic curve will descend into the Lonza torrent beyond. The snow swept down by avalanches in this region somtimes attains a depth of 80 feet. In February, 1908, a building of the railway works was struck by the rush of air set up by a snowslide, and was swept bodily into the river below. There were 11 men in the building, and all of them lost their lives.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 6.

1,034,571. LIQUID-SEPARATOR. Egbert A. Bidwell, Jefferson City, Mo.

1,034,602. COMPOUND AIR-COMPRESSOR. Alexander England, Wilkinsburg, Pa.

3. In a compound compressor having high and low-pressure cylinders and pistons, a shaft for driving said pistons and connections between the pistons and shaft so spaced as to produce a continuous net resistance on said shaft throughout a complete revolution.

1,034,646. PROCESS OF PURIFYING HYDROGEN. Gustav H. Rabenalt, Dover, N. J.

1,034,703. APPARATUS FOR RAISING WATER. Nat H. Freeman, Denver, Colo.

1. The combination with a water supply source, of a standpipe whose lower extremity is in communication with said source, a plurality of pipes arranged one within the other within the standpipe, the outermost pipe being suitably spaced from the inner surface of the standpipe, and the various pipe members within the standpipe being suitably spaced from each other, whereby the space through which the water is to be raised is suitably subdivided, the lower extremities of the compartments formed by the said pipes being open and in communication with the water supply, and means for introducing air under pressure into the standpipe outside of the outermost pipe member, the pipe members constituting the compartments through which the water is to be raised being equipped with air jet nozzles, whose outer extremities are in communication with the air under pressure within the standpipe, a reservoir with which the upper extremities of the compartments are in communication, and means for exhausting the air of the said reservoir above the water, substantially as described.

1,034,739-40. FLUID-CLUTCH. Alvin H. Shoemaker, Portland, Oreg.

1,034,863. PNEUMATIC STAMPING PLANT. Hans Charles Behr, Johannesburg, Transvaal.

1,034,894. AIR-PUMP. Peder Andersen Fisker, Copenhagen, Denmark.

1,034,919. PRODUCTION OF AERATED BATHS. Andreas Walther Leuschner, Dresden-Alt, Germany.

1,034,961. PNEUMATIC CONVEYER. Edward F. Birkenkamp and Theodore F. Birkenkamp, Farmersville, Ill.

1,034,988. PNEUMATIC-POWER PAINTING-MACHINE. Francis Dykes, Elizabeth, N. J., and David E. Wells, New York, N. Y.

1,035,012. INSECT-DESTROYER. Charles Van Pelt Hoselton, Carterville, Mo.

1,035,022. CUSHIONING DEVICE FOR USE ON CARS. Laurence L. Leasure, Winfield, Kans.

1,035,117. LUBRICATOR. George H. Gilman, Claremont, N. H.

AUGUST 13.

1,035,135. CLUTCH MECHANISM. John M. Anderson, Fullerton, N. D.

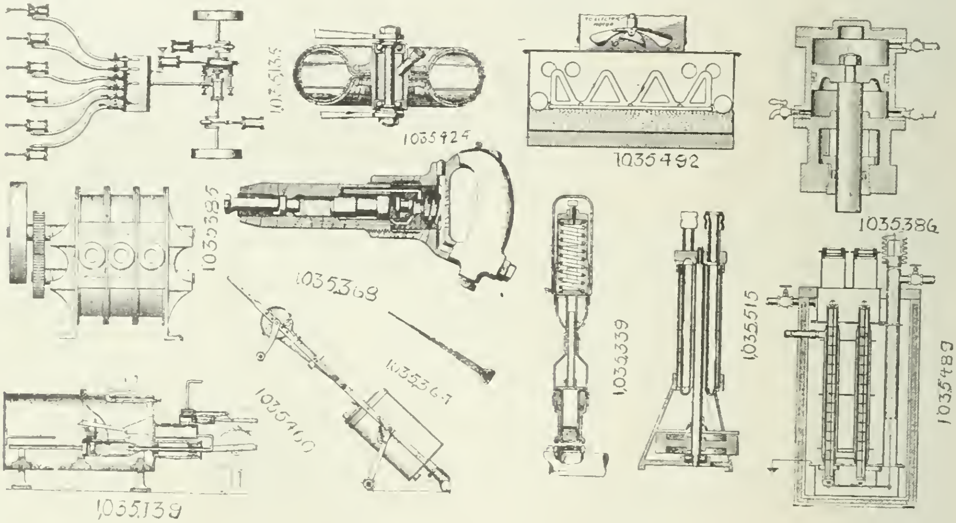
1. In a machine of the class described, the combination with a drive shaft having a friction disk keyed thereto, an eccentric loosely fitted on the drive shaft and having a friction disk bolted upon one face and concentric with the shaft, a pulley having a peripheral groove secured upon the other face of the eccentric and concentrically with respect to the shaft; a collar seated in said groove and extending beyond the same, and means connected with the collar and operable by air pressure to move the friction disks out of engagement with each other.

1,035,139. AIR-COMPRESSOR. Charles P. Augustine, Hamilton, Mont.

1,035,281. AIR-DRYING APPARATUS FOR METALLURGICAL PURPOSES. Bruce Walter, Pittsburgh, Pa.

1. In air drying apparatus for metallurgical purposes, a tower having superimposed compartments, a partition separating the compartments and arranged to allow upward flow of air therethrough while preventing downward flow of liquid, means for passing air upwardly through said compartments in succession, and means for subjecting the air to the action of separate refrigerated liquids in the said air compartments; substantially as described.

1,035,337. AIR-TESTING APPARATUS. Walter H. Flood, Chicago, Ill.



Pneumatic Patents, August 13.

1,035,339. LIQUID CUSHIONING DEVICE. Thomas J. Fox, Memphis, Tenn.

1. In apparatus of the class described, the combination with a pipe, of a cylinder in communication with the interior of the pipe, a plunger working in the cylinder, a spring resisting movement of the plunger away from the pipe and means whereby substantially the entire pressure of liquid in the pipe may be transmitted to the plunger through a cushioning body of confined air.

1,035,341. PNEUMATIC CLEANER. Charles Burdette Gilmore, Bloomington, Ill.

1,035,358. PNEUMATIC HAMMER. Harry Keller, Philadelphia, Pa.

1,035,364. ELASTIC-FLUID COMPRESSOR. Maurice Leblanc, Croissy, France.

1. In a rotary elastic fluid compressor, blades composed of vegetable fibers stretched parallel to each other radially to the rotor and united together by a suitable agglutinant, substantially as described.

1,035,372. VACUUM-SWEEPER. Frank J. Matchette, Milwaukee, Wis.

1,035,385. BLOWER OR PUMP. Albert W. Pearsall, Lowell, Mass.

1,035,386. AIR-CUSHION FOR PUMPS. Frederick M. Prescott and Euclid P. Worden, Milwaukee, Wis.

1,035,424. PNEUMATIC WHEEL. Charles De Los Rice, Hartford, Conn.

1,035,460. VACUUM CARPET - CLEANER. David A. Minnich, York Pa.

1,035,489. APPARATUS FOR THE PRODUCTION OF OZONE. Jan Steynis, Bay Shore, N. Y.

1,035,492. HUMIDIFIER. Charles Subert, Chicago, Ill.

1,035,515. HYDRAULIC VACUUM - PRODUCER AND AIR-COMPRESSOR. Martin Armstrong, Kansas City, Mo.

1,035,603. AIR-WASHER. Morris S. King, New York, N. Y.

1,035,684. METHOD OF PRODUCING COMPOUNDS OF OXYGEN AND NITROGEN. Paul Bunet, Paris, and Adrien Badin, Salindres, France.

1. A process for electrically producing compounds of oxygen and nitrogen, which comprises supplying successive layers of air to successive electric arcs, in a restricted space in which the reaction takes place, and in extinguishing the arcs by a cooling fluid acting at the outlet from the reaction chamber, the cooling fluid not passing into the said chamber.

1,035,802. PNEUMATICALLY - OPERATED ELEVATOR SIGNAL SYSTEM. Barney Meyer, Chicago. Ill.

1,035,804. AIR-COMPRESSOR. Mike Mintz, Rock Island, Ill.

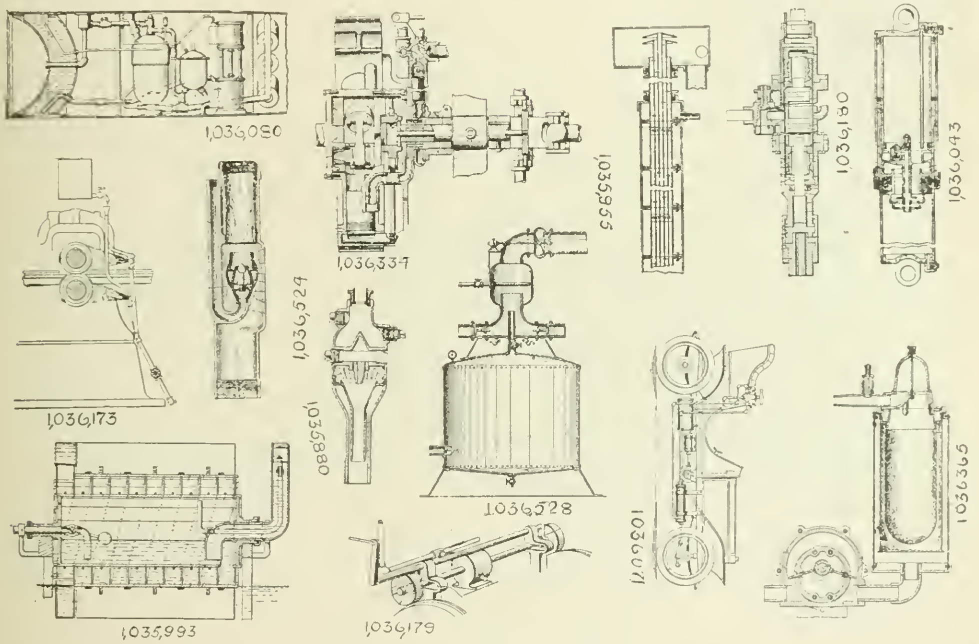
1. In an air compressor, the combination with a motor, pumps, a compressed air tank, a diaphragm valve interposed between said pumps and tank, and means for reducing the pressure in the system between the pumps and diaphragm valve to atmospheric regardless of the pressure in the remainder of the system.

AUGUST 20.

1,035,880. VACUUM-PRODUCER. Harry A. Jeffery, Cleveland, Ohio.

1,035,955. APPARATUS FOR ELEVATING WATER. Nat H. Freeman, Denver, Colo.

1,035,993. AIR-LIFT PUMP. Walter B. Moore, Seattle, Wash.



Pneumatic Patents, August 20.

1,036,043. FLUID-PRESSURE DEVICE. George Westinghouse, Pittsburgh, Pa.

1,036,071. FLUID - PRESSURE STEERING APPARATUS. Edward E. Bryant, Chicago, Ill.

1,036,080-1-2. APPARATUS FOR GENERATING MOTIVE FLUID FOR AUTOMOBILE TORPEDOES. Gregory Caldwell Davison, Quincy, Mass.

1,036,173. COOLING AND LUBRICATING APPARATUS FOR DIES AND METAL-WORKING MACHINES. Fred C. Arey, Oak Park, Ill.

1. In combination, co-operating rotary slitting dies arranged one above the other, a work-receiving table lying in advance of the dies to support the work in position to be fed between the dies, an atomizer arranged above the table in position to direct a current against the upper die, a second atomizer located below the table in position to direct a current against the lower die, means for delivering a lubricating material to said atomizers, and means for supplying the atomizers with air under sufficient pressure to cause a considerable lowering in the temperature of the air through adiabatic expansion.

1,036,179. AUXILIARY AIR-PUMP FOR LOCOMOTIVE ENGINES. George A. Bosworth, Lincoln, Nebr.

1,036,180. ROCK-DRILL. William L. Brookins, Telluride, Colo.

1,036,254. PROCESS OF PRESERVING HAMS. Paul Jorn, Hamburg, Germany.

The process of preserving a ham consisting in salting and smoking the said ham, removing the bones therefrom, dipping the ham in boiling water, compressing the ham in a mold of approximately its own shape, partly cooking the ham in the said mold, packing the ham in a can of approximately its own shape, sealing to the can a cover having a vent hole, exhausting the air from the can through the vent hole, hermetically sealing the vent hole, the walls of the can being so weak and the exhaustion of air from the can being carried so far that the pressure of the atmosphere thereon collapses the walls thereof tightly on to the ham, and finally processing the sealed can.

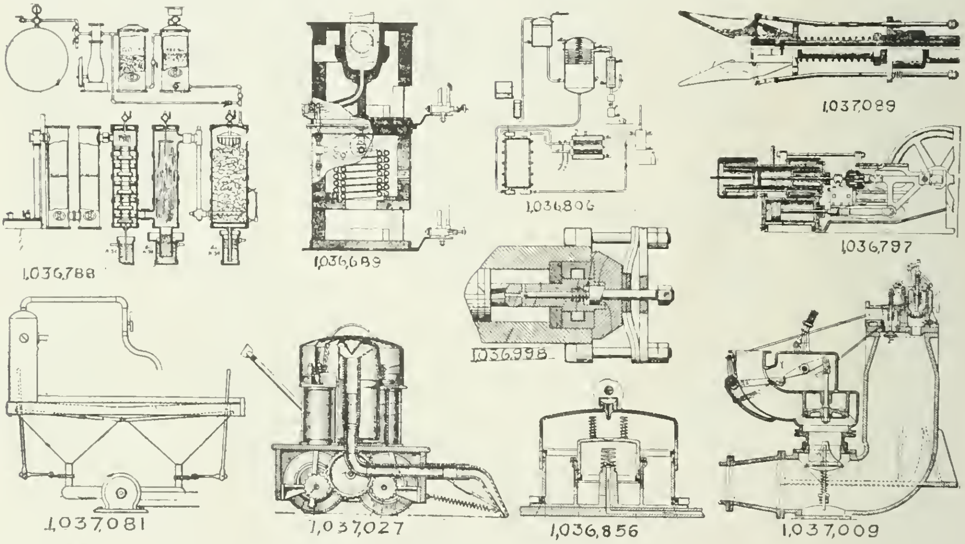
1,036,334. PNEUMATIC POWER TRANSMISSION. FRANK MONROE PRATHER, Los Angeles, Cal.

1. A driving member, a driven member, cylinders connected with one of said members, pistons in the cylinders and connected with the other member, means including valves for controlling the circulation of air through the cylinders, a storage chamber and check valves opening only upon excessive pressure in the cylinders to place the cylinders in communication with the storage tank.

1,036,340. CUSHIONING DEVICE. ALBERT F. ROCKWELL and CHARLES F. SCHMELZ, Bristol, Conn.

1,036,365. CLEANING APPARATUS. EARL C. STAFFORD, Wilkinsburg, Pa.

1. In a cleaning machine, the combination of a chamber provided with inlet and outlet ports or openings, depending receptacles having permeable walls arranged in the chamber, one within but separated from the other, the receptacles being so arranged that the inlet port will discharge into the inner receptacle, and means for maintaining a practically uniform flow of air through the chamber and receptacles.



PNEUMATIC PATENTS, AUGUST, 27.

1,036,378. VALVE CONNECTION FOR PNEUMATIC CLEANING SYSTEMS. CHARLES R. THURMAN, Pittsburgh, Pa.

1,036,524. AIR-LIFT PUMP. FRANCIS S. MILLER, Indianapolis, Ind.

1,036,528. APPARATUS FOR COOLING AND REFRIGERATION. OTTO KUPHAL, New York, N. Y.; Helen Kuphal, executrix of said Otto Kuphal, deceased.

1. The combination, with means to direct a blast of expanding compressed air, of a mixing-tube into which said blast is discharged, an evaporator-casing into which said mixing-tube debouches, a spraying device so located with respect to the evaporator-casing and the incoming air-blast as to be in the vacuum produced by such blast, and means for sucking the resulting cooled air from the evaporator-casing.

AUGUST 27.

1,036,627. ROTARY COMPRESSOR. ALBERT HUGUENIN, Zurich, Switzerland.

1,036,656. POWER-PNEUMATIC FOR PLAYER-PIANOS. JOSEPH LEISCH, Tryon, N. C.

1,036,689. PROCESS OF AND APPARATUS FOR ATOMIZING METALS, ETC. JAMES MILLAR NEIL, Toronto, Ontario, Canada.

1. The herein described process of atomizing metal, etc., consisting in exuding molten metal upwardly through an opening in a flat surface and directing a forcible blast of an atomizing agent against the exuding molten metal so as to first flatten the exuding metal in a film on said surface and then dissipate the metal off said surface, substantially as set forth.

1,036,788. PROCESS OF OBTAINING SUBSTANTIALLY PURE NITROGEN FROM THE AIR. CHARLES BLAGBURN, Antioch, Cal.

1. A continuous process of obtaining substantially pure nitrogen from atmospheric air which consists in causing molten sulfur to flow in a stream, feeding sulfur and supplying air at one end of said stream while restricting the amount of air supplied so that no more oxygen will be present than is sufficient to combine with the sulfur from said stream, compelling the whole of the air to flow, in its whole course, close to the surface of the burning sulfur, conducting away, while confining, the sulfurous acid, unburned sulfur, and nitrogen, depositing the unburned surfur, washing out the sulfurous acid, and collecting the nitrogen, substantially as described.

1,036,797. AIR OR GAS COMPRESSOR. OLIVER H. CASTLE, Indianapolis, Ind.

1,036,806. PROCESS AND APPARATUS FOR STERILIZING MILK AND OTHER ORGANIC LIQUIDS. JOSEPH DESMAROUX, Paris, France.

1,036,856. PNEUMATIC SHOCK-ABSORBER FOR VEHICLES. GUSTAV KANTER, Murtoa, Victoria, Australia.

1,036,998. FLUID-OPERATED PERCUSSION-TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,037,009. METHOD OF RAISING OR FORCING LIQUID. HERBERT A. HUMPHREY and ALBERTO CERASOLI, London, England.

1,037,027. VACUUM-CLEANER. CHARLES A. LINDBERG, Bradford, Pa.

1,037,081. PNEUMATIC CARPET-CLEANER. ROBERT W. THORNE, London, Ontario, Canada.

1,037,083. VALVE FOR VACUUM CLEANING SYSTEMS. CHARLES R. THURMAN, Pittsburgh, Pa.

1,037,089. AUTOMATIC COUPLING FOR AIR-PIPES. CASPER WALERIUS, St. Paul, Minn.

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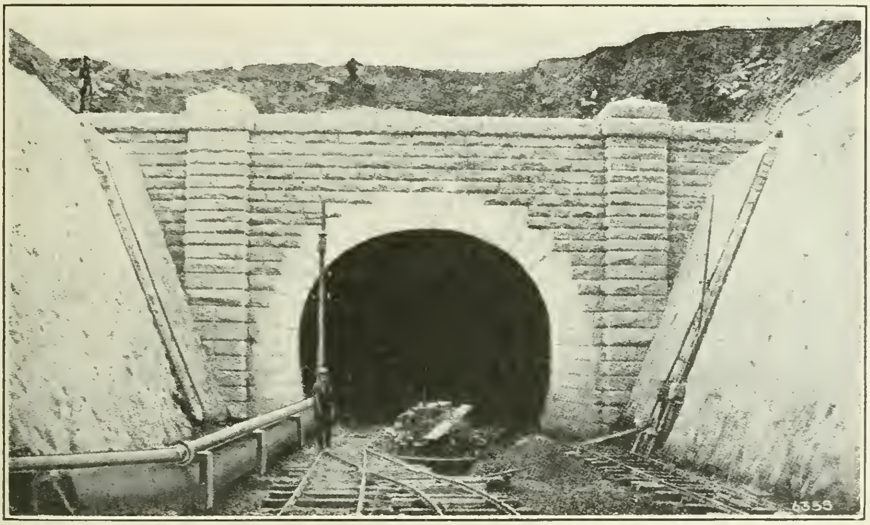

FIG. 1. PORTAL OF MT. IKOMA TUNNEL.

DRIVING A DOUBLE TRACK TUNNEL IN JAPAN

By W. L. Saunders.

The Japanese people have given us many evidences of their progressiveness, but nothing emphasizes their spirit of progress more than the work which they are now doing in building a double track, broad gauge electric railway between Osaka and Nara. Osaka has been called the Pittsburg of Japan. It is the commercial metropolis, with one million inhabitants, covering an area of more than eight square miles, intersected by the river Yodo and with numerous canals running through it. Osaka is admirably situated for a manufacturing city. Its principal trade is with China. On arriving at Osaka one is impressed by its industrial activities, as illustrated by the large number of chimneys. Old Osaka has left its monument in the great Castle, built by Taiko Hideyoshi in 1583. Little remains of the old Castle but the ruins, and principally the walls of the moat. These walls contain huge blocks of hard granite, some of them measuring 40 feet in length and 16 feet in height.

From Osaka to Nara is from new to old Japan, for Nara is in every respect representative of what Japan used to be. It was the ancient capital during seven reigns and until the seat of government was removed to Kyoto. At Nara is the largest statue of Buddha, built in the year 746.

The railway now under construction is a short cut designed to reduce the time of travel and the mileage. The line runs through Mt. Ikoma, which is located about half way between Osaka and Nara.

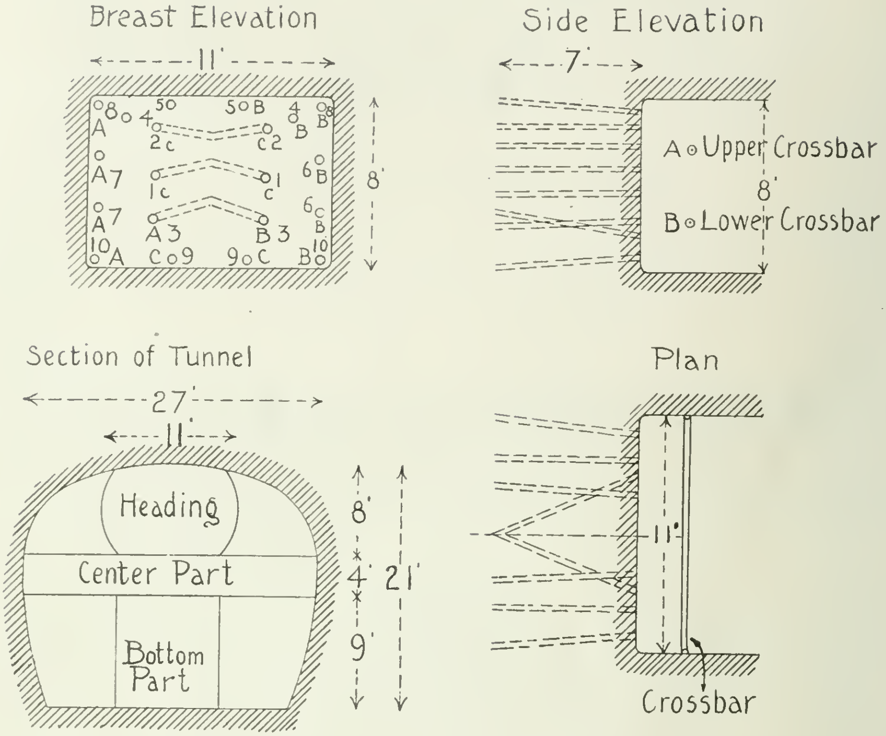

FIG. 2. SHOWING DRILLING LAYOUT.

The contract for the construction of this tunnel was awarded to Obayashi Gumi, the engineering work being in charge of Dr. Eng. T. Oka. The tunnel work begins in the eastern end at Ikoma Village, extending westwardly to Hineichi Village, a distance of about two miles. The finished dimensions of the complete tunnel are 22.2 ft. in width by 19.35 ft. in height. Work was begun on the 3rd of July, 1911, and is now being prosecuted from the two portals.

The attached sketches and plans, Fig. 1, show the methods pursued in this work. The upper sketches represent the heading, one being an elevation showing the breast and the other a vertical section or elevation through the heading. The lower sketch to the left is a section across the tunnel, illustrating the entire width and height and showing the heading in the upper central part with the center prism separating the heading and the bench or bottom part.

To the right and to the left of the heading and to the right and to the left of the bench are sections which are excavated by the use of stoping drills. The center prism is also removed in the same manner. The plan to the right of this section shows the cross-bar used for mounting the drills in the heading.

The heading is 8 ft. high and 11 ft. wide; the center part is 4 ft. high and 27 ft. wide; and the bottom part or bench is 9 ft. high and 8 ft. wide.

In the heading a bar 5 inches in diameter and 10 ft. in length is fixed horizontally across the tunnel. Jack screws, located in each end of this bar, serve to adjust it to proper lengths and to fix it rigidly against the walls. Three water-Leyner drills are mounted on this bar, and the upper holes are drilled first. Then the bar is lowered to a point nearer to the bottom of the heading and the lower holes are drilled.

Because of the use of these light weight drills, which do not kick hard against their mounting, it is possible to employ this bar in place of the usual columns. Columns with arms are mainly used in America because

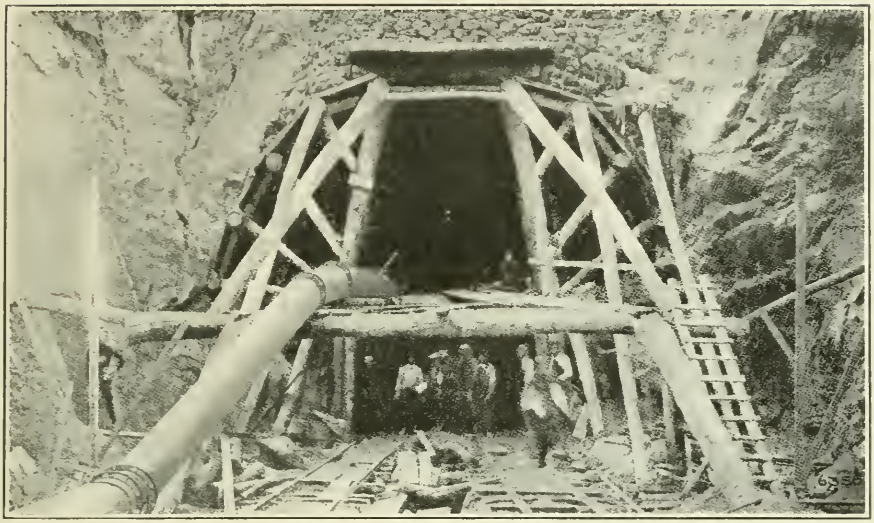

FIG. 3. SHOWING VENTILATING PIPE.

drills of the percussion type require a very rigid mounting. It is obvious that the use of the horizontal bar facilitates the handling of the drills and makes it possible to set up after a blast quicker than by the use of columns. The whole thing with the drills mounted is handled readily by a gang of men, who climb up over the muck, placing the bar in position and drilling the holes while the muckers are at work below them.

The center or cut holes are drilled to a depth of 8 ft., all the other holes being 7 ft. in depth. Blasting is done by time fuse, which is admitted nowadays to be the best practice. Gelatine is placed in the bottom of the hole next the primer, over it is placed some gelatine and them 60 per cent. dynamite. Clay is used for tamping. Where the rock is hard from 22 to 26 holes are drilled in the heading, but in softer rock this number is reduced to 16

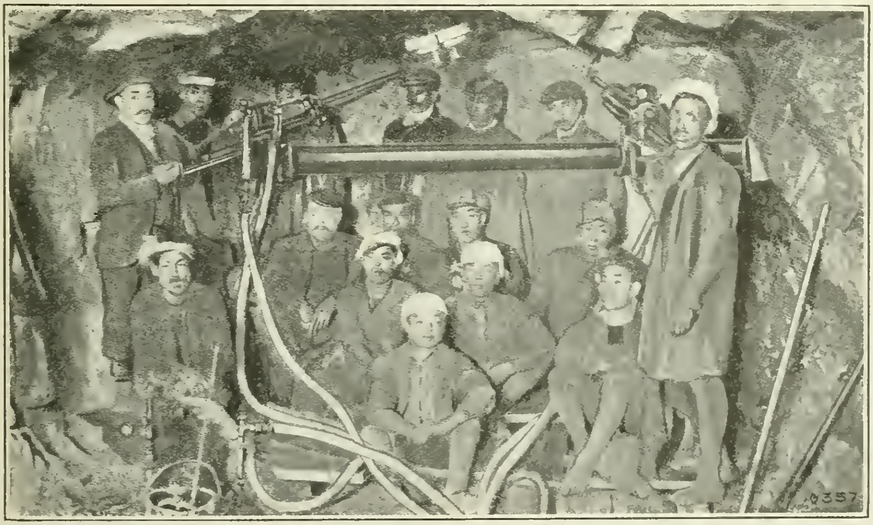

FIG. 4. DRILLS AND JAPS AT HEADING.

holes in some cases and in others as low as 12 holes. The rock in Mt. Ikoma is granite, usually hard, especially in the east end.

Progress in this tunnel has averaged over 10 ft. of heading per day. Records have been made of 20 ft. in 24 hours, single heading. This was on the west side where the rock is of moderate hardness. It usually requires five hours to drill 20 holes, 6 ft. to 7 ft. deep. The work of loading, firing and taking out the rock consumes about three hours, or a total shift of 8 hours, the miners working day and night. One superintendent is in charge of each heading, with three drillers and three helpers.

Mine cars of wood are used, with a carrying capacity of 30 cubic feet; track 30 inch gauge, 25 lb. rail, the train of 10 cars being hauled by an electric locomotive.

For ventilation 50 H. P. Root blowers draw the air through a 20-inch pipe. Both the compressed air pipe and the ventilation pipe are seen in the half-tones, which require no other remark. Ingersoll-Rand Air Compressors of 115 H. P. each furnish the compressed air at 100 pounds pressure, the air being conducted to the heading through a 5 inch pipe.

The holes drilled are usually about 2 inches in diameter and the progress of the drills is from 7 to 12 inches of hole per minute. Although water is fed into the bottom of the hole the discharge of the cuttings is really effected by compressed air, which is forced in with the water, the minimum amount of water being used and only for the purpose of laying the dust.

Power at the portals of the tunnel is transmitted electrically a distance of 16 miles at 3500 volts; 16 candle-power electric lamps are used for lighting. Up to May 31, 1912, an advance was made in the east end of 2127 ft. and in the west end 1917 ft., or a total progress of 4044 ft. The tunnel is to be lined with brick, about 1000 ft. being already completed.

DRILL STEEL

Much has been written pertaining to the results achieved by drills of modern design. Little, however, has been published in regard to the steel of which the drills bits are made. The time has now come when any further increase of drill power must be attended by the use of stronger and better steel, for even some of the machines now in use strike so hard a blow that trouble is frequently experienced from the bending of the best grades of high-carbon drill steels, or under the shower of rapid blows of the air-hammer drill the phenomenon called "crystallization" causes annoyance through the breaking of cutting edges and shanks of the bit.

There has been a tendency even among the contractors to dispense with use of large steel, and inch or 1¼-in. steel is now the standard in most drilling work. The hollow steels, particularly the round section, are gaining favor, and their adoption is rapidly extending. The star or cross-section is highly esteemed in the West, because of the greater clearance afforded for the ejection of cuttings.

The air-hammer drill has been a stimulus to steel manufacturers to produce a higher quality of material, and some are now investigating the merits of alloy steels. One company has already placed a vanadium steel on the market and a Western company has given an order for a consignment of chrome steel for experimenting with drill bits of that material. It is a growing opinion that these alloy steels will ultimately be proven not only to be superior to ordinary drill steel, but absolutely necessary if more powerful machines are built. At present however, alloy steels for drill bits have not been proven to be better than the best American and Swedish drill steels.—*Eng. and Min. Journal.*

A NEW ALTITUDE RECORD

On September 17th Georges Legagneux made a new record for altitude for monoplanes at the Villacoublag aerodrome, attaining a height of 5,720 meters, or more than 3½ miles. His feat was rendered possible, in a way, by the use of oxygen, and this not for himself but for the motor. The first thousand meters were ascended in two and a half minutes; the next two stages of one thousand meters required five minutes each; the four thousand meter mark was reached in seven and a half minutes more; and the five thousand meter mark was attained in the next fifteen minutes. The full height of five thousand seven hundred and twenty meters was attained in forty-five minutes, which is rather quick work as climbing goes. The descent from a height of more than three and a half miles was made in less than ten minutes. Above a height of 10,000 feet motors work with great difficulty and soon stop. In submarine boats, too, the motors stop long before the crew begin to feel any evil effects from the exclusion of oxygen.

SHAFT UPRAISING PROFITABLE

BY LUCIUS L. WITTICH.

Both in point of time and of money a great saving was accomplished on the property of the Nowata Lead and Zinc Company, at Duenweg, Mo., when a new shaft was made by driving an upraise to the surface. H. Correll, manager of the company, undertook the work of upraising on his own responsibility after having received bids for sinking the shaft by contract. The lowest contract bid received was $15.50 per foot, for a shaft 5 ft. x 7 ft. in the clear, put down to a depth of 210 feet. This would have meant an expenditure of $3,255, to say nothing of the greater time required. Although the upraising was purely an experiment, the first instance of the kind in the Missouri-Kansas-Oklahoma district, and although many unforseen difficulties arose which can be remedied in subsequent operations of a similar nature, the aggregate cost of upraising the shaft was only $1,273.58, or $6.06 per foot. This saving of $1,981.42 has convinced the company that where it is possible to start at the bottom, that is the wise course to pursue. The company has started a second upraise for a shaft, and it is safe to prophesy that the cost figures will show a still greater saving.

The existence of a 6-inch drill hole at a point where his company desired to sink a new shaft caused Mr. Correll to consider the advisability of using the hole as a medium through which a cable could be passed, to support a working platform at the lower end. Fig. 1 shows the plan adopted in upraising for the shaft. At the top, near the drill hole opening, was stationed a hoister, which was operated so little of the time that an expenditure of 50 cents a day for natural gas for fuel defrayed the cost As this was a minimum flat rate it was in excess of what would have been charged had only the gas really used been paid for. The drill hole extended into the drifts of the mine, the distance from the surface to the roof of the drift where the drill broke through being 210 feet. Through the drill hole was lowered a ⅝-inch cable, which passed over a pulley in a derrick and thence to the hoister.

At the lower end, the cable was attached to a specially constructed platform, built of 2"x 4" and 4"x4" oak lumber, the size of the platform being 4 ft. 8 in. x 6 ft. 8 in., thus leaving 2 inches in the clear, all around, when the platform was hoisted into the upraise. The aggregate weight of the platform, operators, and equipment was 800 pounds, divided as follows: stoping drill, 110 pounds; steel, 50 pounds; two operators, 300 pounds; platform, 340 pounds.

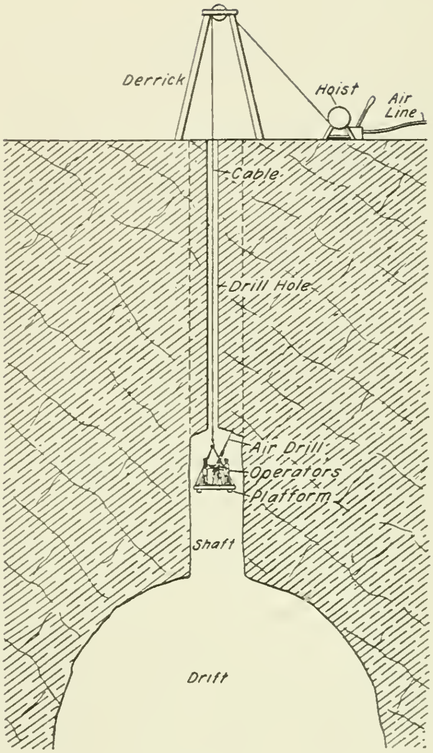

FIG. 1.

Starting the shaft in the roof of the drift was much the same as starting it in solid ground at the surface. The 5'x7' space was marked out, with the drill hole as its center, and the work of shooting down the rock started. The platform was supported by four iron bars, fastened at the corners of the platform, and meeting at a point above the center, high enough to permit the operators to work freely. A hook permitted the cable to be detached from the platform; thus when shots were fired the platform was lowered to the floor of the drift and pulled to a point of safety to be out of the way of falling rock, while the detachable cable was hoisted up the drill hole in order that it might not be damaged by the blast.

From the time the first round of shots was placed in the roof of the upraise until the shaft was completed, cribbing being included, fifty-two 8-hour shifts were required. This was about a third of the time usually required for sinking a shaft of similar dimensions. The cribbing was installed from the bottom up.

In upraising, 14 holes were driven to a depth of 5 feet in the roof, as shown in Fig. 2. Six of these corresponded to the ordinary sump holes used in sinking a shaft from the top down, while eight corresponded to the cut holes, four of these being driven near the corners and four along the edges, midway between the corner holes. Each hole was loaded with four sticks of dynamite, a total of 56 sticks for one charge. Forty-per-cent. dynamite was used. During the upraising of the first 100 feet the shots were fired from below, the electrical shot firer being stationed in a drift. During the remainder of the work, the shots were fired from the surface. A signal cord down the drill hole enabled the operators to signal to the hoisting engineer.

The 18 feet of surface soil was shot down at a single blast, the drill hole being plugged at the bottom and loaded with dynamite. The result of the blast was an opening more than large enough to accommodate an ordinary mine bucket, and in this bucket workmen were lowered and the edges blasted out and trimmed. It was this final step that Mr. Correll considers his one big mistake. He believes matters could have been expedited by first sinking from the surface down to the hard limestone, then beginning the upraise. As it was, an enormous mass of surface dirt was shot into the drifts when the surface was blasted down, and this became a sticky mass following a heavy rain. It was almost impossible to remove it, and as a result much valuable time was lost. The surface caved, also, to some extent, but heavy concrete walls were built down to the limestone, thus making it secure.

The upraising method has many advantages over the former methods of shaft excavating employed in the district. Ordinarily in shaft sinking the necessity of removing the pumps before each blast, or the necessity of at least covering them with heavy timbers, is of greatest importance. Repairs are constantly being made to the pumps as the result of damage from the shots. Water is invariably rising in the sump and the workmen have an unsanitary place in which to toil. As virtually all of the larger mines of the district frequently used from one to half a dozen extra shafts, exclusive of the mill shaft, and as the underground workings usually connect, the possibility of making an upraise is found on every hand.

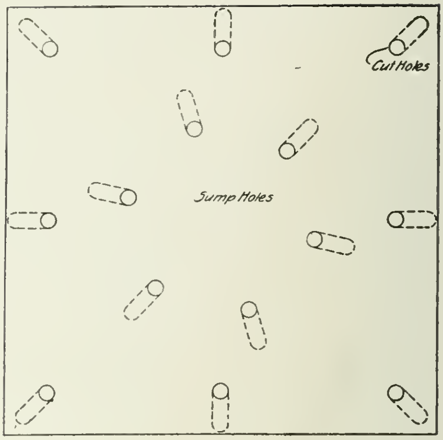

FIG. 2.

The cost item of $1,273.58 includes the fuel, wages, powder, timbering, every feature in fact of the work; it even includes the purchase price of the stope drill, $135. However, it does not include the cost of sinking the 6-inch drill hole, which was already at hand. If it had been necessary to sink such a hole, the added cost would have been 80 cents per foot, including the casing, meaning a total of $168 to be added to the figures already given. Many mines, however, have their drill holes already sunk, that can be used as was the one of the Nowata company.

At all times the ventilation was good, as the fumes quickly lifted through the drill hole. In this respect the method is even better than the methods of upraising employed in many of the western mines, where pens are built to hold the working platforms. In such cases the air may become foul at the highest point of operation. *Mines and Minerals.*

Beware the blandishments of the scientific management expert who can look at the tongue of your wagon, feel the pulsations of your boiler feed line, take the temperature under your collar, and prescribe off-hand a sure-cure system, whose principal principle is "change everything."—*Chained Lightning*, Louisville Ltg. Co.

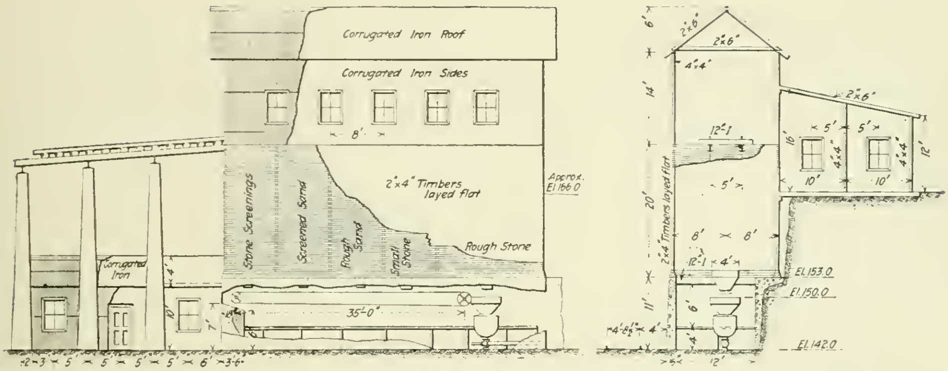

FIG. 1. GENERAL LAYOUT OF MIXING AND CONVEYING PLANT.

A COMPRESSED AIR CONCRETE MIXER AND CONVEYOR

A concrete plant in which the entire mixing and conveying operation is carried on by the use of compressed air has been in successful operation for some time on the McCall Ferry power plant of the Pennsylvania Water & Power Co., at Holtwood, Penn. This power house, was originally designed for 10 hydro-electric units, but it was put in operation with only five such units. The projected increase in size is now being made and requires not only the installation of new turbines, but also the construction of that part of the power house.

The new structure is being built by the company with its own forces under the direction of L. H. Eichelberger, the construction superintendent, and the design and operation of the compressed-air mixing and conveying plant are due to Mr. Eichelberger.

The plant consists essentially of an air compressor, a material storage house with connections to separate bins for the different materials, an automatic measuring device, an inclosed tank into which the materials and water are placed to be mixed by the agitation of a compressed-air stream and a delivery pipe leading from this tank to the place of deposit. The compressors, storage house and mixer are permanently located at a place convenient to the railway siding so that material may be easily brought there, but the delivery pipe can be led to any place on the work where it is required.

DESCRIPTION OF PLANT.

Figs. 1 and 2 show the general layout of the plant. At the extreme left is the compressor with pipes leading to the mixer as shown. The mixer is located under the storage house in line with the hoppers from the various material bins, which hoppers empty upon an electric motor driven belt conveyor, which de-

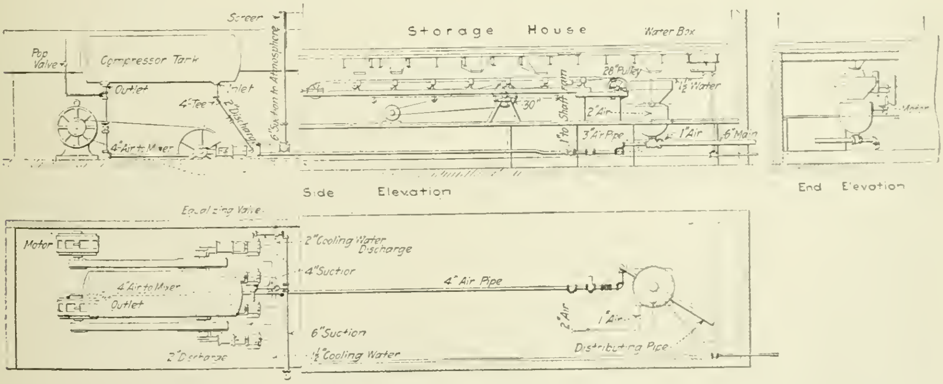

FIG. 2. DETAILS OF MIXING PLANT.

livers the materials to the upper hopper of the mixer.

The storage house is shown in Fig. 1. At the bottom of each bin is a hopper as detailed in Fig. 3 for some of the bins. These hoppers are built so as to contain units or multiples of a unit amount. The rough-stone and small-stone hoppers contain twice as much as the sand or screening hoppers, and the unit is twice the contents of a sack of cement, so that for the mixture used in the work, 1:2:4, the sand hopper and the stone hopper each is filled once to form the proper mixture.

Each of these hoppers is closed at its upper part by a gate sliding horizontally, with all the gates actuated by a single horizontal shaft leading to a piston at the extreme right, as shown in Fig. 3. Each of the gates is connected to this shaft by a slip bolt. The piston is in connection with an air pipe leading from the compressor tank, so that by pulling the lever by the side of the mixer the proper gates, which have been locked by the slip bolt, are opened and the hoppers are filled to the proper amount. The operator can then close them by shoving back the lever. In mixing the concrete different materials are used in different parts of the work and the operator empties the hoppers designated for the particular work in hand by pulling the radial bottom door, shown in Fig. 3. At the same time, the cement, which is stored in sacks at the extreme right of the storehouse as shown, is led to the mixer by a chute from above and the water is fed from a barrel immediately alongside the mixer. In feeding the mixer, therefore, the one man controls the material from his place by the mixer and an exact proportion is assured. The mixing tank shown in Fig. 4 is the one in use at the McCall Ferry plant. The mixer consists of a conical upper hopper leading through an opening, which can be tightly closed, into a lower tank where the mixing operation takes place. This lower tank in the original design is a cylinder joined above a hemisphere with an opening at the bottom through which the material is delivered to the conveying pipe. It is built of wrought iron, ⅜-in. material being used for the tank, hopper and doors and ½-in. material for the top head of tank. It was tested before use to stand 175 lb. per sq. in. pressure.

In addition to the main entering pipe, shown at the upper right-hand shoulder of the lower tank, through which the main force of the air is applied, there are a number of holes tapped for ½-in. pipe in the upper shoulder and the lower part of the periphery of the tank. In these holes are placed ½-in. pipe turned on an angle so as to deliver air in a circumferential line, thus causing a whirling motion of the material inside the tank. These pipes are all connected to one of the lines of pipe from the compressor, though this connection is not shown in the drawing. The bottom of the tank is not closed by a gate, but opens directly into the conveying pipe, which, however, takes a right-angle turn to a horizontal position immediately below the tank. In line with this conveying pipe is a 3-in. pipe from the compressor, which operates as noted below, to force the mixed concrete along the pipe.

In operation the material is dumped by the belt conveyor, as noted above, into the upper hopper, which is closed tight with the cone valve shown. When the materials have been placed in the hopper the cone valve is dropped, by a horizontal lever (not shown in drawing) connecting to the vertical rod attached to the valve, into the lower hopper and the valve is closed at the same time air is turned on to the main 2-in. pipe in the upper right-hand shoulder of the tank and to the small whirling jets noted above. The whirling jets tend to mix the material, while the air from the 2-in. pipe forces the concrete into the conveying pipe directly in front of the 3-in. air jet below, which blows the material through the conveyor pipe to the end of the line.

The conveyor pipe in use on this mixer at McCall Ferry is the ordinary 6-in. wrought-iron pipe, flange connected. On leaving the mixer it takes a slight curve in a horizontal plane and continues for some 300 ft. approximately level to a juncture point where it is led to the different places needed on the work. At this juncture point there is a vertical pipe leading to the top of the power house about 100 ft. above the level of the lower pipe and a horizontal continuation leading to the penstocks and turbine settings. For the end of the delivery pipe originally a box with a curved surface opposite the end of the pipe was devised, but it was soon found that it was just as easy to use a 14-in. T joined to the end of the 6-in. pipe with the horizontal branch opposite the delivery end closed with an iron plate, backed on a wood bulkhead. The material hitting this end soon built up a small cushion of concrete and formed a natural

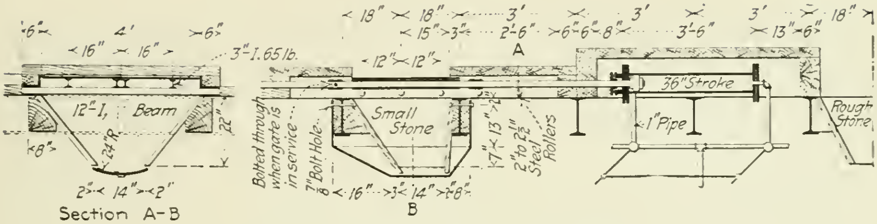

FIG. 3. DETAILS OF HOPPERS AND GATES.

curve around which the concrete was delivered to the vertical drop pipe of the T.

OPERATION OF PLANT.

When the concrete plant was first installed there were available only two compressors, each having a capacity of 300 cu. ft. at 100 lb. pressure, and in addition to the concrete plant a number of drills and repair-shop machines had to be run. Since then another compressor has been installed, so that the machine may be worked to its full capacity. The rated capacity of the mixer is ½ cu. yd., and, working at a minimum distance of 380 ft. with a maximum of 490 ft., the machine has uniformly been mixing and conveying at the rate of 40 batches, that is, 20 cu. yd., per hour. It probably could do better than this if more air were available, as the speed of delivery is only restricted by the speed of getting the materials out of the hoppers into the mixer.

For this work the gang consists of one foreman and five laborers, three of whom are required to operate the mixer. The fourth is used at the discharge end of the pipe as a signal man and for the cleaning of the chute, and the fifth man spades the concrete in the forms. There is a reverse-acting electric signal provided at the mixer and the place of the deposit. When the mixer foreman receives the signal from the other end of the line he lifts the cone valve on the mixer and the mixed material is delivered within 30 sec. to the other end of the pipe. About every 20 batches the pipe is blown through without any material, so as to clean out any concrete which may have lodged at various points along the line.

The concrete delivered is of uniform consistency and appears to be a remarkably dense mixture, although the period of mixing is so short. The large-size stone used on most of the concrete will pass a 3-in. ring, so it will be seen that the mixer and conveyor is for concrete and not for grout alone.

Up to the time when 2200 yd. of concrete had been placed there was no apparent wear on the mixer itself or on the straight part of the 6-in. delivery pipe. At the curve of the delivery pipe, however, the outer surface seemed to wear very rapidly, and a design has

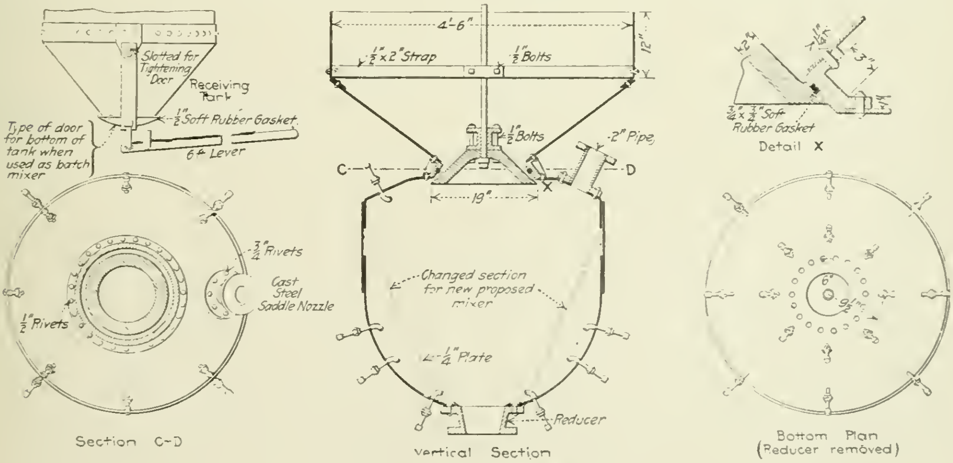

FIG. 4. DETAILS OF MIXER.

been made in which the outer surface is provided with a flange, which can be replaced from time to time. There seems to be no difficulty in raising the concrete to a height of 100 ft., and the delivery at that point is equally efficient and rapid with that on a horizontal line from the mixer.

The mixer was first designed as a batch mixer to deliver directly from its bottom opening to buckets and conveyed by the usual derrick or car methods. Mounted and operated for such a batch mixture, it is placed higher and the large bottom T removed and replaced with the swinging door detailed in Fig. 4. This door holds the materials in the mixer until air is admitted through the mixing jets for a duration of about 10 seconds. The air is then shut off and the door opened to release the mixed concrete. In this way only a small amount of air is required.

The advantages claimed for the device are rapid and economical mixing, together with very economical delivery. In addition for such work as is being done at Holtwood the presence of the usual derricks or car tracks would seriously interfere with the form work and the operation of the present plant. On the other hand, the delivery pipe can be easily led wherever required without interfering with any existing work.—*Engineering News.* (Abridged.)

SUCTION DREDGES IMPROVE THE GULF PORTS

Comparing the conditions at the American ports of the Gulf of Mexico with conditions ten years ago, it is seen that a marked impulse to port development has been involved in the perfection and construction of suction dredges, for these dredges have demonstrated their immense usefulness in accomplishing two results in one effort, namely, the making of new land by the deepening of channels. At Galveston this is evidenced in the increasing area of Pelican Island, which now serves as a protection for Galveston Harbor against the influences of "northers" blowing across Galveston Bay; at Mobile, where several new islands have been brought into existence, whose ownership and control is now being sought from the State of Alabama by the City of Mobile; and at Tampa, where a large marsh area lying to the westward of Ybor City is being transformed into solid land through the cutting of the estuary at Tampa. The possibilities of port development as influenced by suction dredges seem to be almost unlimited around the Gulf, owing to the softness of the average material to be dredged and the absence of any necessity for laborious dredging through rocky material. This is particularly noticeable in Mobile Bay and River. The channel to Mobile, which was about 7 feet deep immediately after the Civil War, has gradually been deepened in the interval to more than 23 feet, with 27 feet in sight. This deep channel stops at a short distance above Mobile and then rapidly shoals until it reaches Spanish Fork, beyond which point, if the intervening area is dredged, it is possible to get into deep water ranging from 30 to 60 feet and running 40 miles northward on the Alabama River.

WATER JACKET TROUBLES

"Most city water contains large quantities of lime and magnesia in solution and these coming in contact with the heated walls of the air compressor precipitate in the form of scale. This scale cuts down the radiating capacity, the air compressor overheats and the efficiency is very greatly reduced. Not only this; but, due to the pressure, the water in the jackets has been known to leak through the packing and get into the cylinders, causing wet air with its attending troubles."

The above is from an exchange which need not be identified. It is a fact that water jackets will not and do not keep clean of themselves, but require cleaning out with a frequency determined by the condition of the water used. As there is practically no evaporation there is little or no deposition of scale as in a steam boiler, but mud or sediment sometimes accumulates rapidly, so that the clearest water obtainable should be used.

The last sentence of the above paragraph is absurd. There is generally no pressure upon the water circulating in the water jacket, never it may be said, as much as within the air cylinder, and in most constructions—packing or no packing—there is no possible communication between the water jacket and the cylinder interior. When there is "wet air with its attending troubles" the water is carried in by the air itself, and there is never any absolutely dry free air taken in.

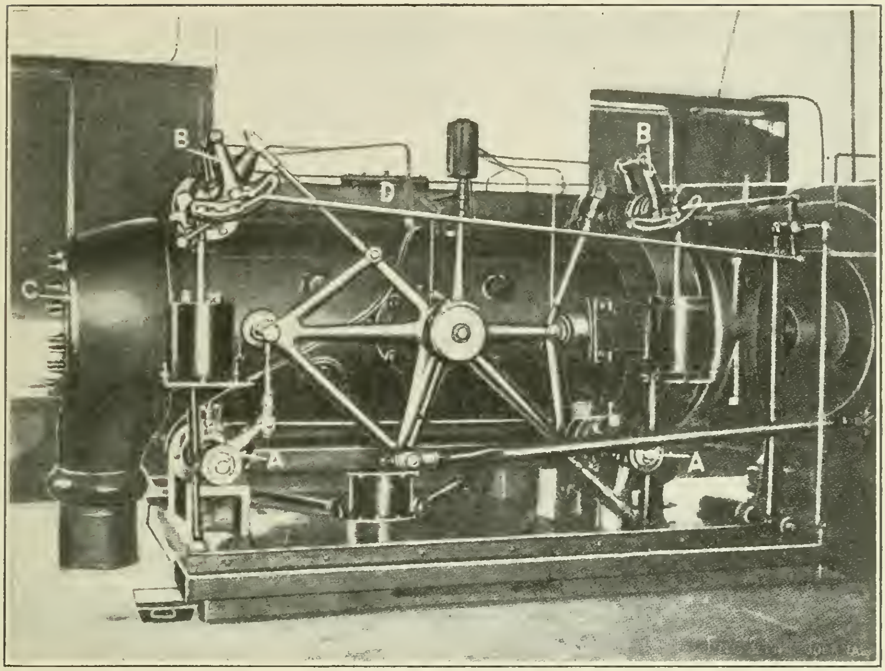

FIG. 1. AIR CYLINDER FRANKLIN HOISTING ENGINE.

THE FRANKLIN AIR-BALANCED HOIST

By R. H. Corbett.*

This hoisting engine was built in conformity with the ideas of R. M. Edwards, general manager of the Franklin Mining Co., and the other Dow properties in the Lake Superior copper district. Mr. Edwards long held the opinion that for deep mining operations a single-compartment shaft would be desirable, provided that a balance hoisting engine could be built to operate a single skip or cage, he considered that the simplicity of a single-compartment shaft and its equipment would warrant any complication of the hoisting engine which would produce the desired result. It was apparent to him that if the power developed by the descending skip could be applied to compressing air it would furnish a solution of the problem.

AIR PISTONS RUN FREE WHILE HOISTING

When the time arrived for ordering a hoist, the matter was placed in the hands of Bruno V. Nordberg to design an engine and work out the details of an air-balanced hoist to meet the requirements. Following this the engine under discussion was built by the Nordberg Manufacturing Co., of Milwaukee, Wis. This hoisting engine is a horizontal-duplex machine with the steam cylinders attached to the frames. The air-compressing cylinders are located immediately back of the steam cylinders. The air pistons are attached to extensions of the steam piston rods, the whole forming a complete hoisting engine and air compressor combined. Means are provided for allowing the steam pistons to run free while lowering the skip. The air pistons run free while hoisting. The engineer regulates the speed of the descending skip by controlling the quantity of air compressed. By means of the operating lever on the platform he absolutely governs the work done in the air cylinders between the limits of full cylinder capacity and no load.

The air compressing cylinders, Fig. 1, have four Corliss valves. The two lower ones *A* admit free air to the cylinders in the usual way. The two upper ones *B* are provided especially for regulating the capacity and are the ones controlled by the engineer while lowering. The air delivered under pressure passes

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*Lake Superior Mining Institute, Houghton, Mich., August, 1912.

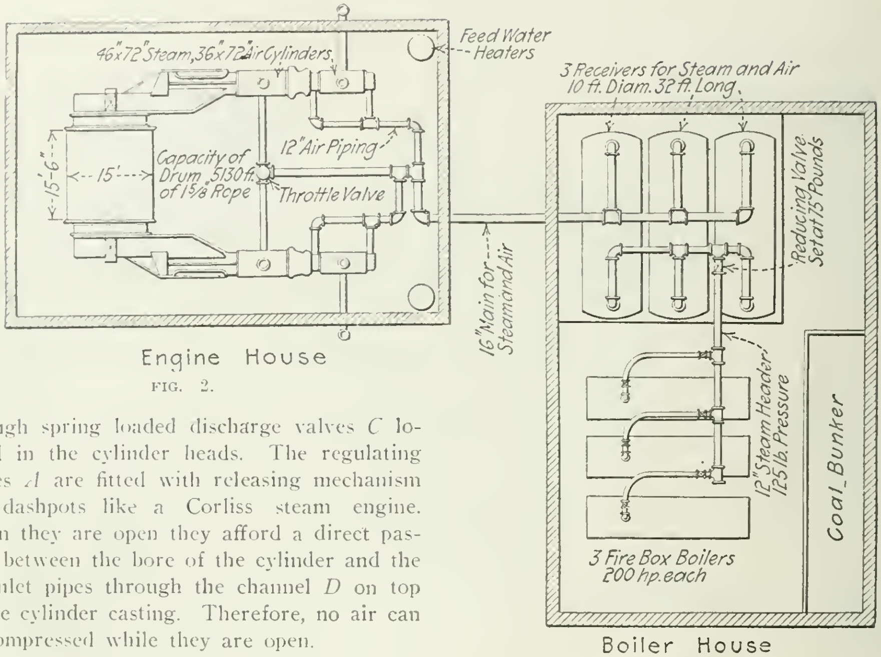

46"x72" Steam, 36"x72" Air Cylinders
Feed Water Heaters
3 Receivers for Steam and Air 10 ft. Diam. 32 ft. Long.
12" Air Piping
Capacity of Drum 5130 ft. of 1 5/8 Rope
15'
15'-6"
Throttle Valve
Reducing Valve Set at 75 Pounds
16" Main for Steam and Air
12" Steam Header 125 lb. Pressure
Coal Bunker
3 Fire Box Boilers 200 hp. each
Engine House
Boiler House

FIG. 2.

through spring loaded discharge valves *C* located in the cylinder heads. The regulating valves *A* are fitted with releasing mechanism and dashpots like a Corliss steam engine. When they are open they afford a direct passage between the bore of the cylinder and the air inlet pipes through the channel *D* on top of the cylinder casting. Therefore, no air can be compressed while they are open.

To illustrate their action we will suppose an air piston is moving toward the end of the cylinder while lowering the skip. If the regulating valve is open the air in front of the piston will be forced back into the inlet pipe. If, however, the engineer trips the valve and the dashpot closes it at any desired point in the stroke, then the air left in the cylinder will begin to compress until it finally passes out through the discharge valves. The arrangement is such, that the further the engineer moves his lever the more air will be compressed and the resistance increased on the air pistons. The air cylinders are only used for regulating the speed while lowering. The usual steam-operated brakes are provided for landing the skip.

To enable the steam pistons to run free while the engine is lowering, the exhaust valves on the steam cylinders are arranged to be released from their connections and remain wide open and stationary until they are hooked up again, when the engine is reversed for hoisting. The releasing and hooking-up mechanism is connected to a small steam-operated thrust cylinder provided to furnish power for this purpose. The operating valve on this cylinder is attached to the reversing gear of the hoisting engine. Therefore, when the engineer reverses his engine the exhaust valves are either released or hooked up again as the case may be, without further attention on his part.

AIR MIXED WITH STEAM FOR HOISTING

While compressed air is usually in demand around a mine, it was decided in the present instance, that it would be best to mix it directly with steam from the boilers and use the mixture in the steam cylinders for hoisting the load. Three large cylindrical drums were installed for storing the compressed air along with the steam. They are each 10 ft. in diameter and 32 ft. long. They furnish ample receiver space at the present time for both steam and air.

Fig. 2 is a diagram of the general arrangement showing how these receivers are connected with the boilers, air compressors and steam cylinders. A 12-in. steam pipe connects the boilers with one end of the receivers. A 16-in. pipe from the opposite end of the receivers is carried to the throttle valve. The 12-in. discharge pipes from the air compressors are connected to this same 16-in. line. This forms a convenient way for the compressed air to reach the receivers when lowering and also to supply the steam cylinders with pressure for hoisting. A reducing valve is placed in the 12-in. steam pipe between the receivers and boilers. It is set to maintain about 75 lb. pressure on the receivers. The boiler pressure is usually about 125 lb.

PRESSURE AUTOMATICALLY REGULATED.

In explaining the operation of this feature of the hoisting engine, we will say that in the first place the receivers are filled with steam at 75-lb. pressure. The skip is then lowered into the mine. The air compressors begin to discharge compressed air into the receivers to mix with the steam they already contain. By the time the skip reaches the bottom of the mine the pressure will rise to 95 lb., the increase in pressure being due to the compressed air forced in by the descending skip. They will then begin to hoist the load and have 95 lb. pressure to start with. After the skip starts upward the pressure will gradually drop to below 75 lb. as the engine uses up the air stored in the receivers by the previous trip downward. The reducing valve will open after the pressure drops and steam will be taken directly from the boilers to complete the trip upward. When the hoist stops the pressure will rise to 75 lb. through the reducing valve and be in readiness for the next trip down.

The following general dimensions and data are given regarding the hoist:

Diameter of steam cylinders	46 in.
Diameter of air cylinders	36 in.
Stroke of all cylinders	72 in.
Diameter of piston rods	7½ in.
Size of crank pins	12x12 in.
Size of crosshead pins	8⅝x14 in.
Size of main bearings	20x40 in.
Diameter of hoisting drum	15.0 ft.
Length of hoisting drum	15.5 ft.
Capacity of drum	5130 ft. of 1⅝-in. rope
Weight of skip	14,000 lb.
Weight of rock	20,000 lb.
Weight of rope per foot	4.15 lb.
Number of boilers required	2
Capacity of each boiler	200 hp.
Number of feed water heaters	2
Dip of shaft	40°

Berryman feed-water heaters are now being installed. The boilers are of the Lake Superior firebox type with crown and arch tubes.

The engineer handles three levers in controlling this hoist, the throttle lever, reverse lever and brake lever, the same number as on other hoists in this section. The throttle lever, however, usually stands in a vertical position when the hoist is stopped. If he pushes it from him it operates the throttle valve; if he pulls it toward him it acts on the regulating valves on the air cylinders. With this exception the hoist handles about the same as other hoists in the copper country.

ROCK DRILLING CONTESTS PRODUCE NEW RECORDS

Interesting and unusual rock drilling contests took place at Calumet, Mich., Aug. 24. In one of these a single man with an air operated drill had for his competitors a three-man team of hand-drillers. Each party was allowed 15 minutes of actual drilling; at the end of that time the hammer and drill team had drilled 49 in., breaking their record set a few weeks previously at the miners' picnic, by a quarter of an inch. The man with the machine-drill holed through the rock, 60 in., with one minute to spare, winning the prize of $50. The hammer and drill team was composed of the winners of the hand-drilling contest held at the miners' picnic, William Billadeau, Matt Kramerich, and Charles Seppala; the man with the machine drill was John Becker. The rock-drill used was an Ingersoll-Rand, Butterfly valve, one-man machine. Two other contests were held at the same time, which were essentially trials of speed in 'rigging-up' one-man and two-man machines. Each team was required to 'rig-up' its machine, drill for two minutes (to show that the job was a satisfactory one), and then put in a new drill steel.

In the two-man contest there were 20 teams entered, practically every mine in the copper country being represented. The Ahmeek team, composed of Patrick Dunnigan and Archie Paulson, won the first prize of $100, and did the work in 3 min. 42 sec., taking only 1 min. 42 sec. to 'rig up' and put in the drill. The Calumet & Hecla Amygdaloid team won the second prize of $50; the Wolverine team won the third prize of $25.

In the one-man drill contest there were 17 teams entered. The Calumet & Hecla Amygdaloid team won the first prize in 4 min. 33⅗ sec., John Bosio constituting the team. Allouez took second, and Wolverine third. The prizes were the same amounts as in the two-man contest. The two-man drill used was of Ingersoll-Rand make; the one-man drill was an Ingersoll-Rand Butterfly machine.

The contests in rigging-up drill machines are in line with the recent policy of the Calumet & Hecla M. Co., which is conducting a thorough campaign in efficiency engineering in underground work. It is reported that the expense of changing from the two-man to one-man machines will aggregate a quarter of a million dollars, but such astounding reductions are being attained in cost of driving and stoping that this sum will be made up in the saving of the first year or two. The innovations were first tried out in the Superior mine and were so successful there that they are now being introduced in the other mines of the company.

ALCOHOL TO PREVENT AIR-EXHAUST FREEZING

Alcohol is used to prevent freezing at the exhaust of the air-operated shot drills in use at the site of the new station in New York of the N. Y. C. & H. R. R.R. The New York Central railroad has had occasion to do an enormous amount of core drilling within the last 15 years, and in this work several types of drills have been used. One of the most interesting outcomes of the work is the freezing-prevention appliance that can be readily chine where trouble is experienced from freez- adapted for use on any small air-operated ma- ing at the exhaust.

Alcohol is admitted to a vertical part of the air-supply pipe and close to the machine. The device used for feeding the alcohol is attached to the feed pipe as is a lubricator. It consists of a piece of 1½-in. pipe about 12 in. long, fitted with bushings at the top to take a piece of ½-in. pipe six inches long. The small pipe is closed by a valve. The other end of the 1½ in. pipe is fitted with bushings to take a 3-in. piece of ½-in. pipe, to which a valve and an elbow are attached and into the elbow another short piece of ½-in. pipe is screwed. The threaded end of the last-mentioned pipe is screwed into a hole tapped into the air pipe so that when screwed tight the 1½-in. pipe is parallel to the air pipe.

By opening the top valve, the 1½-in. pipe can be filled with alcohol. That valve is then closed, and, when the machine is operating, the lower valve is opened just enough to permit drops to pass slowly. The admixture of alcohol vapor in the air effectually prevents freezing at the exhaust. The 1½-in. pipe is usually filled with alcohol twice per shift.—*Eng. and Min. Journal.*

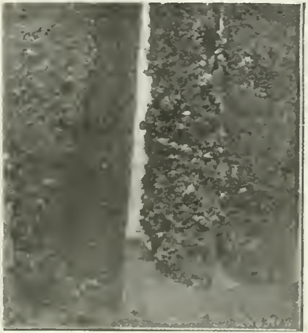


FIG. 1.

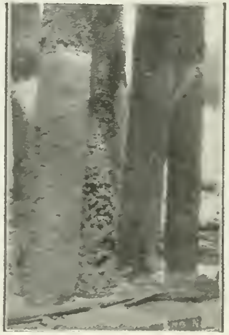


FIG. 2.

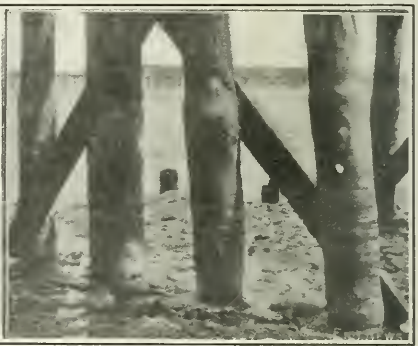
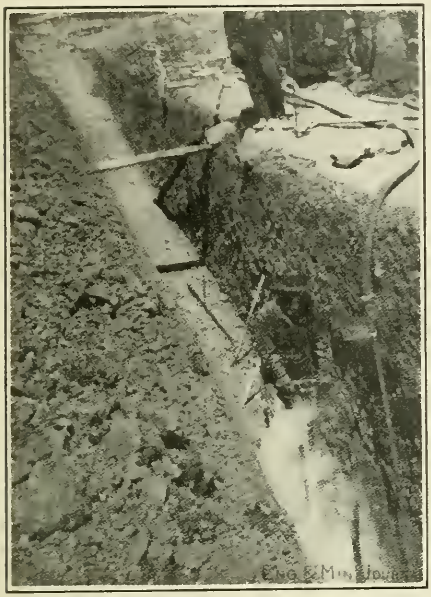


FIG. 3.

PROTECTING TIMBER PILES WITH CEMENT GUN-CONCRETE

Timber piles in marine work in northern Pacific waters are very apt to be attacked by the so-called sand-flea and rapidly eaten away. In a timber wharf for the Seattle Electric Railway Co., at Seattle, Wash., these attacks became so great as seriously to endanger the safety of the structure (Fig. 1), and covering the piles by concrete thrown on from the cement gun was resortd to with considerable success.

Figs. 2 and 3 illustrate the process and the final appearance of the coated piles. Ordinary poultry wire was stretched around the piles and a cement-gun mixture driven against the reinforcement from the nozzle of a cement gun, to a thickness of from 1½ to 2 in. The work was done between tides and the mortar received its set before the water reached it. About 500 piles were coated in this manner at a cost of about $4 per pile.—*Engineering News.*



HAMMER DRILLS IN A TRENCH.

HAMMER DRILLS OPERATED BY STEAM

By P. B. McDonald.*

A contractor in Duluth, while recently excavating a trench 18 in. wide and 4 ft. deep in tough trap rock, found that he was losing money. He had eight drill crews of three men each, who drilled 18 in. per crew per day, or a total of 12 ft. per day. The contractor went to a mining-machinery man to talk it over. Obviously some small "plug" drills were needed. The job did not warrant buying an air compressor, and up to that time plug drills could not be operated by steam, as the valve mechanism expanded with heat and stuck. Besides, the small tortuous ports produced "wire-drawing" of the steam to which compressed air being quicker, was not subject.

Fortunately a new plug drill had just been put on the market which could be operated by steam, due to the advantages of the recently improved "Butterfly" valve. The contractor bought two of these drills and a 3-hp. portable boiler. For the remainder of the job two men, using the plug drills, drilled 6 ft. per man per day, or a total of 12 ft. per day; the other 22 men were dispensed with. The foreman having little to do, attended to the boiler, occasionally throwing in a chunk of coal. The fuel cost was less than $1 per day. The deepest holes drilled during this work were 4 ft., but this was easily done, and 6-ft. holes could have been put down readily. Thus the drills proved to be the solution of what might have been a difficult problem.

Another use of plug drills which is receiving attention, is for secondary work, such as blockholing large masses which have been blasted by means of holes drilled with heavy reciprocating drills. Under the old method, reciprocating machines on tripods were used to put in holes spaced closely enough to break the rock into small fragments, as hand drilling of chunks was slow work. Now it is possible to space the holes put in with the reciprocating drills so as to break large masses and slabs, which can then be broken up readily by plug drills. By this change of policy in breaking rock, higher efficiency can often be obtained.

On the Mesabi range, plug drills are now used in connection with steam-shovel work to break up boulders, hard pan, frozen ground or rock. The steam for operating can be obtained from the steam-shovel boiler. This method is rapidly superseding the old custom of hand drilling in pit work.

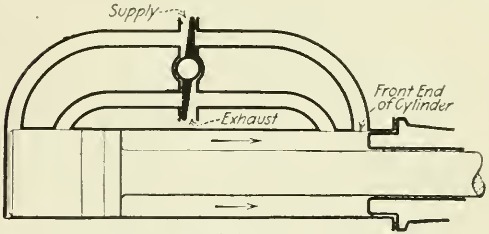


FIG. 1

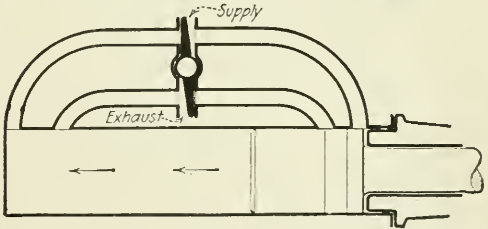


FIG. 2

The butterfly-valve mechanism is shown in the accompanying drawing. When the valve has flapped to one side as in Fig. 1, the air supply is connected with the back end of the cylinder and the exhaust with the front end. When it has turned to the other end, the conditions are reversed. It is evident that the structure of this valve is better adapted for use with steam than are spool and tappet valves, which are likely to stick and which are fed through narrow ports.—*Eng. and Mining Journal.*

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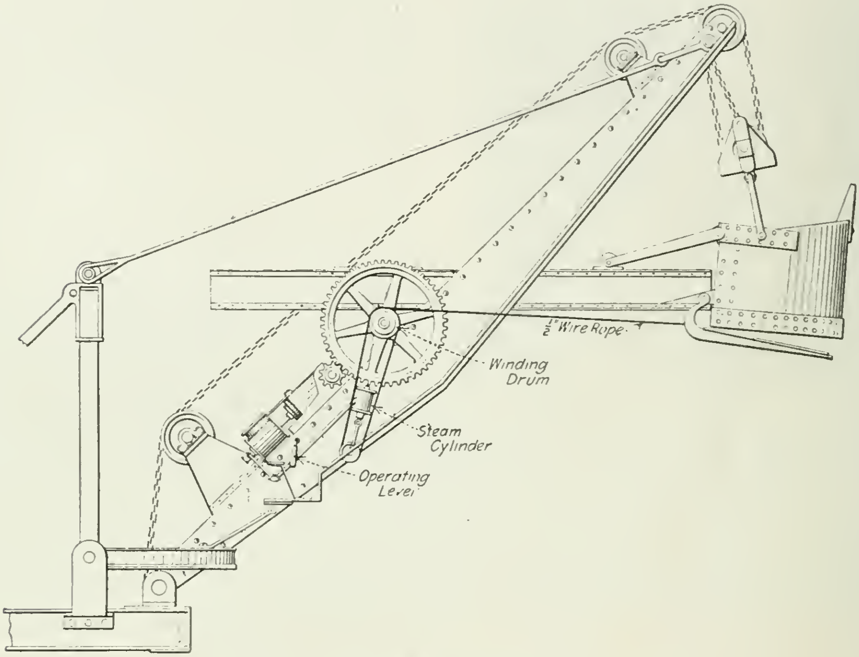
*Mining Engineer, Negaunee, Mich.



DEVICE FOR DUMPING DREDGE BUCKET.

WHY NOT AIR INSTEAD OF STEAM ?

For an operation which must be repeated for every lift of a steam shovel, or for every dip of a dipper dredge, an operation often calling for all the strength of the operator, the pulling of the latch which dumps the load, it is quite a wonder that until recently no power actuated device has been adopted for the purpose. The steam trip here shown was adopted only last year on the 95 ton shovels in service on the Panama Canal.

The device consists of a grooved drum of the same diameter as the rack pinion, which is fastened to the end of the dipper shaft and revolves with it. A steam cylinder or ram, carrying an idler sheave on its pushout rod, is bolted to the side of the boom below the engine. The drum carries an idler sheave, a half-inch flexible wire rope from the dipper latch passes over this sheave, over the ram sheave, and is then wrapped around the grooved drum, and the rope-end secured thereto. As the dipper stick runs in and out, the rope is wound on or off the drum at the same speed, so as to maintain the same degree of tautness at all times. To dump the dipper, a three-way cock located beside the craneman is opened, admitting steam to ram, pushing out the idler sheave, thus pulling the rope and tripping the latch instantly. After this operation, the ram is relieved, and returns automatically. The exhaust steam from the ram is piped inside the boom members and away from the craneman's field of vision. For shovels up to 5-yard dippers, a 6x8 inch ram cylinder is used. This size ram gives a pull of approximately 2,800 pounds, which, together with the long stroke, obviates entirely the "hair trigger" adjustment of the latch levers necessary when the old style of handpulled latch is relied upon.

This arrangement works quite successfully, and not only saves the strength and smoothes the temper of the craneman but also secures more rapid manipulation. It certainly would work more satisfactorily if air were used instead of steam. This would apply also to the dipper shaft engine. The exhaust nuisance would be got rid of entirely and also the condensation troubles which always result when steam driven apparatus is operated intermittently as in this case.

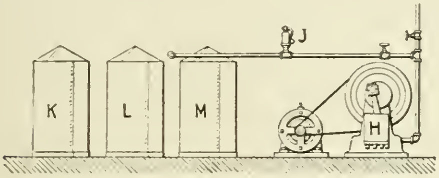


FIG. 1. ARRANGEMENT OF PIPING

EMPTYING AN OIL BARREL

To empty an oil barrel is more or less a troublesome job. We draw our daily supply from three storage tanks for use on gas engines and a supply of oil has also to be placed in the engine crank cases from time to time, to replace that used or drawn off when the machines are cleaned out.

The arrangement shown in Fig. 2 has more than paid for itself; it spills no oil on the floor and eliminates all the strong-arm work of lifting the barrel. It consists of a gooseneck *A* made of ¾-in. brass pipe; the short end acts as a spout and can be inserted into the filling hole in the tank or run into the crank case.

The long end will reach the bottom of the bulge in a barrel when inserted through the bunghole and takes out nearly every drop of oil. A 1x¾x1-in. tee *B* can slide up and down on this leg, making the device adjustable for use in drawing oil out of receptacles having a hole big enough to admit the pipe. A ¾-in. short nipple *C* at the lower end of the tee can be fitted into the barrel bunghole, the thread on the nipple making a joint usually tight enough for the purpose. If the bunghole is large, some waste will make this joint tight. The upper 1-in. outlet is fitted with a reducer *D* and babbitted to fit the brass tube. This serves as a gland, as a little oil makes it slip easily on the tube and at the same time acts as packing. The 1in. side outlet is fitted with a reducer *E* into which a brass tube *F* about 3 in. long is screwed, the outer end being screwed into a brass bushing whose outside is threaded to fit a ½-in. hose coupling *G*.

A small electrically driven air compressor *H* was available which supplied compressed air for starting the engines. A globe valve and a tee were inserted in the line leading to the air receivers, Fig. 1. From the outlet of the tee a line was run over to the oil storage tanks where it connected with a ½-in. hose about 8 ft. long. A globe valve controls the admission of air to this line in which a small pop safety valve *J* with a light spring limits the pressure to about 7 lb.

When a barrel is to be emptied into one of the tanks it is rolled in on the floor and blocked. The gooseneck is inserted through the bunghole and the ¾-in. nipple screwed in to hold it; the brass pipe reaches to the bottom of the barrel and over the tanks *K*, *L* and *M*. The globe valve controlling this line is opened and the compressor is started pumping air into the barrel while the oil flows into the tank. The device requires no further attention until the barrel has been emptied, which is known by the air coming out of the spout.

The safety valve with the 7-lb. spring is an important accessory. Some oils are not as fluid as others, and the carrying capacity of the ¾-in. brass goose-neck is limited. With a heavy oil the air pressure may rise rapidly; the safety valve limits the rise to a pressure the barrel can safely withstand and one sufficient to overcome the hydrostatic head of the oil.—*Power*.

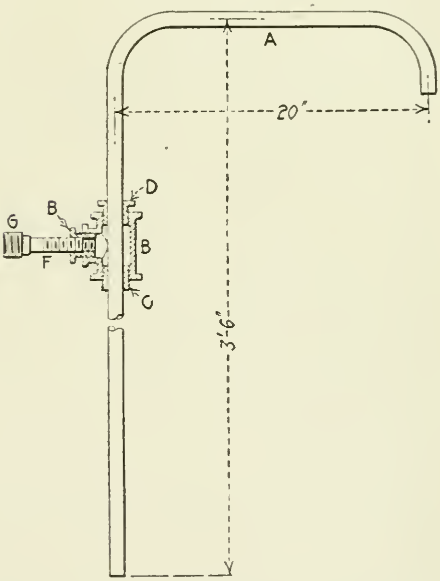


FIG. 2. DETAILS OF AIR-OIL LIFT NOZZLE

USE AND ABUSE OF PNEUMATIC TOOLS

A Pneumatic Tool has a peculiarity over any other operative device, inasmuch as the piston or actual working member of the tool, is not rigidly connected to any other part of the mechanism, but is floating, as it were, in the cylinder and propelled in one direction or the other by the air being admitted at each end of the piston, either by a valve as in the case of Plug Drills and Rock Drills, Hand Facers and Surfacing Machines, or by the piston itself as is the case in Carving Tools. It is for this reason that so little in the way of dirt, cutting of the piston or barrel, or improper lubrication may be sufficient to cause a decided loss in the working efficiency of the tool.

The highly polished, accurately fitted surface of the internal parts of a Pneumatic Tool are particularly susceptible to the action of rust, caused by dampness when not in use, and a tool should never be laid away, even over night without the precaution being taken of inserting a few drops of oil in the inlet, attaching to the hose and running the tool for a second, so that the oil will be carried through by the air and form a thin film on the working parts.

A much better plan, however, and one that is practiced successfully in a large number of plants, is to have a tank large enough to hold all the tools in use filled with kerosene or gasoline, and when the tools are not in service, keep them immersed in the oil. This serves a double purpose; the tools are kept from rusting and the gasoline or kerosene cuts and softens any deposit of oil or dirt in the air passages of the tool that may come from the Compressor. In the morning the tool should be connected with the hose and thoroughly blown out, then disconnected, a little oil (just a few drops) used, and it is ready for operation.

A few drops of oil inserted at intervals of a couple of hours throughout the day should be sufficient. Always use a light, limpid mineral oil, and under no consideration whatever use an animal oil, such as lard oil, sperm, etc., as these have a tendency to gum and clog up the air passages. Many tools coming into the shop for repairs plainly show the ill effects of using animal or heavy mineral oil. Often times it is necessary to boil them in lye water for a number of hours in order to loosen up and remove the deposit of oil and gum in the parts. Even this is not sufficient in many instances, and the removal of a casing and replacement of same is necessary in order to properly clean out the passages.

When a Carving Tool refuses to run, the trouble almost invariably is due to the piston or inside of the barrel having become roughened by a bit of dirt or grit. To remedy this take the tool apart and with a piece of fine emery or crocus cloth, or oilstone, rub the abraded part of the piston smooth. It more often happens that the piston is roughened than the barrel, and if it is found that the barrel has suffered also, take a stick about the radius of the hole and with the emery cloth carefully smooth out the rough place. Then dip the tool in kerosene, blow out thoroughly with air, and put together and it will generally be found to operate satisfactorily. Never put a piston on a grindstone to smooth down a rough spot, as the chances are that the piston will be ruined.

Sometimes difficulty is experienced in starting a new tool, due to the snug fit of the piston in the barrel. In a new tool, when properly fitted, the piston is not more than one-quarter thousandth of an inch smaller in diameter than the barrel in which it works, so you can readily understand why it does not require much dirt in order to cause trouble. It is therefore necessary that the greatest precautions should be taken during this breaking in period, as it might be termed, of a new tool and care and attention paid it until the piston has become worn absolutely smooth, as the least particle of dirt or grit will either cause the tool to stop entirely, or will cut the piston to such an extent that it will be necessary to take the tool apart and dress the piston and barrel as before mentioned. It is for this reason also that a new tool frequently runs warm during the first few days of its use. This fact that a new tool runs slightly warm when first started is rather a point in its favor than otherwise, as it is an indication of a perfect fit of the piston in the barrel, and this running warm will generally disappear after a few days' service.

3/8" hose has come to be regarded as the standard hose for use with Carving Tools. This is correct as far as the size of the hose goes, provided the passage in same is not obstructed by pieces of the inner tube becoming torn and rolling up, or by the use of nipples or fittings in which the openings are too contracted. We have known instances where complaint was made that a tool was not as efficient as it might be, and on examination found the hose in some part of its length to be so obstructed by the rolling up of the inner tube that there was left a passage of an actual diameter of less than ⅛", which size opening will not permit the proper quantity of air to pass through to operate a Carving Tool to its best efficiency.

When attaching a tool to the hose, always see that the nipple is screwed tight into the head, otherwise the jar and vibration will soon destroy the threads on both the nipple and in the head. It is a very good plan to screw a male and female nipple in tight in the head and leave it there, then the threads of the head are protected and the nipple can easily be replaced when worn out. As a matter of convenience, many workmen prefer to use the tools loose on the nipple, which, if the nipple is screwed directly into the head of the tool, will soon ruin the threads, and especially where this is the case the M & F nipple should be used without fail.

Trouble is often experienced due to the hole in the nipples being too small. Never use a nipple with a Carving Tool which has a clear opening through it of less than a quarter of an inch, and the larger it is, the better, as it causes less friction and wire drawing of the air in its passage to the tool. To get the best results from a Carving Tool, or in fact any Pneumatic Tool, the supply of air at the tool should be kept as near as possible at the Receiver pressure, and any contraction or clogging of the passages, either in the hose, nipples or cocks, will cause a lowering of the pressure at the tool, consequently lowering its efficiency. Of course, in work like fine carving, etc., it is necessary at times for the workmen to throttle off the air at the cocks and the above remarks do not apply in this case.

If a tool does not start immediately when the air turned on, some workmen make a practice of striking the nose end violently against the stone or other hard substance in order to start it, which should not be done, as it is apt to injure the tool. In nine cases out of ten it can be started by simply placing the thumb over the exhaust port and removing it suddenly. If this does not start it, insert a chisel in the tool and strike the chisel lightly against the stone.

The bushing in a Carving Tool should not be allowed to become excessively worn before replacing. In many instances where tools are sent in for repairs the bushing has been worn entirely through due to the workmen always holding the tool in one position. Where this condition exists the piston is likely to fracture owing to the fact that the chisel is not held square in the tool and the piston strikes it an oblique or glancing blow.

It would seem almost unnecessary to caution against the use of a pipe wrench on the barrel of a Pneumatic Tool in taking same apart, but the fact that we continually have tools coming into the shop for repairs on which the casings have been ruined, and in many instances the barrel broken or cracked by the use of a pipe wrench would seem to indicate that a few words on this subject might not be wasted. There is no make of Pneumatic Tool on the market at the present time that we know of, on which it is necessary to use a pipe wrench to remove the head. If flats are not provided or if they have worn off so that an ordinary wrench cannot be used on the head and barrel, a proper procedure to follow is to clamp the head in a vise, and with a short piece of ¼" or ⅜" rope, take several turns around the body of the tool and with a stick or a lever through the bight of the rope, unscrew the tool from the head, seeing that the locking pin is properly depressed and there is no mechanical obstruction to the removal of the head except the friction of the threads.

Another point in which economy can be exercised in the use of Carving Tools is to have the proper tools for the work in hand. In other words, do not try to do a heavy rough job with a ¾" or 1" tool, when an 1¼" tool would do it in one-half the time. It will not take long to pay for the extra tool.

One more point, and an important one, that should be observed in the use of Pneumatic Tools, is to see that when the workmen lay them down temporarily they are not thrown indiscriminately into a pile of dirt, as stone dirt and grit finding entrance through the lower end can do just as much damage as if it came through the hose from an unscreened compressor suction. Workmen should also be instructed to thoroughly blow out the hose and see that it is perfectly clean before screwing the tool on to the nipple, as it is common practice to let the end of the hose drop into the dirt when the tool is unscrewed, and more or less of this will find its way into the tool to the serious detriment of same if this precaution is not observed. Blowing out the hose also answers another purpose, in that it disposes of the water which might have settled in the pipe and hose during its period of nonuse.

Chisels used in Carving Tools should receive constant and careful attention. The upper end of the bushing in the tool is provided with a shoulder which acts as a stop for the end of the chisel shank, and the piston is proportioned as to length, so that when it comes down and strikes a chisel held up against this shoulder, the exhaust ports in the upper end of the barrel are opened just the proper amount to allow the air to escape from the upper end and the piston to make a full return stroke. Therefore, it is obvious that the shanks of chisels should be kept square on the end, and full size up to the end. If they are dubbed off on the end, or are so small that they pass up at all beyond this shoulder, they will prevent the piston from making a full downward stroke, the air pressure at the upper end will not be relieved, and the complaint will be made that the tool has lost its power. Of course, after long continued use the shoulder of the bushing will gradually be worn so that it lets the chisel up too far, and the same result of loss of power will be observed, but in this case it is better to send the tool in to the shop for adjustment and repair.

The matter of keeping chisels square and flat on the end is extremely important. When the end of a shank is rounding, the impact of the piston's blow is not distributed over the entire striking surface of the piston as it should be, but is concentrated in one particular spot with a consequent liability of fracturing the piston. As a matter of fact, a far greater number of pistons are broken in this way than there are due to defects in the pistons themselves.

It is, of course, just as easy to make the shank of a chisel hard as it is the piston, and the certain consequence if chisel shanks are as hard, or harder than the piston and do not have a true surface at the upper end, is that the piston must suffer, so it is always good practice to have the shanks of chisels softer than the piston. The proper color or degree of hardness is what is termed pigeon blue.

Point and bush chisels used in Surfacing Machines, and hollow steels used in Rock Drills, are particularly subject to breakage in the shank after a longer or shorter period of use, due in most cases to crystalization of the metal caused by the incessant vibration incident to their use. A way to very effectually curtail this breakage is to periodically, say every two weeks in the case of Surfacing Tools where they are constantly being used, anneal the shanks by heating them to a low red heat, covering up with ashes and allowing them to cool slowly; then after they are cool, reheating and toughening the end of the shank. This annealing process allows the molecules of the metal to assume their original positions or conditions from which they have been disturbed by the constant impact of the piston.

Shanks of chisels used in Hand Facers and Plug Drills should be 2½" long from the end of the shank to the extreme end of the fillet. It is important for the proper operation of these tools that this length be maintained as accurately as possible, as the length of the shank determines the stroke of the piston. In dressing chisels used with Hand Facers, Plug Drills and Surfacing Machines, see that the end of the shank is perfectly flat with a small bevel at the upper edge.

From the point of efficiency it is best to use as short and light a chisel as possible in connection with a Surfacing Machine, as when a long and heavy chisel is used, a large portion of the energy and momentum of the piston or hammer is taken up and absorbed by the inertia of the chisel due to its weight, so that the actual work accomplished would be in inverse ratio to the weight of the chisel. The efficiency of a Surfacer can easily be reduced 25 to 50 per cent. by the use of inordinately heavy chisels, and you can readily see that if this weight of the chisel was carried to an extreme limit, a point would soon be reached where the piston would have practically its whole energy consumed in the chisel, and very little work would be accomplished.

When a Plug Drill, Hand Facer, or Bumper as they are commonly called, or Surfacing Tool stops suddenly, in nine cases out of ten the trouble is something small and unimportant. Outside of the possible breakage of an important part like the piston, the usual difficulty will be found to be either a cutting of the piston or barrel due to dirt or grit, as has been mentioned in connection with Carving Tools, or the stoppage of some port or passage by dirt, or a piece of the rubber lining of the hose. The first thing to do in case a tool of this kind stops is to take it apart and determine if the valve and piston are uninjured and in perfect working order. If this is the case, take a piece of wire and probe the ports in the valve box and barrel, and you will generally find the difficulty. When a tool stops on account of wear, it does not stop suddenly, but gradually falls down in efficiency and at last refuses to run. For a considerable length of time before stopping entirely, however, its efficiency is so reduced as to be readily noticeable.

When a tool of this kind stops from wear the trouble is not as is generally supposed in the valve, but is due principally to wear on the tit of the piston or in the lower end of the barrel where the piston comes through. In the case of Surfacing Machines this would be the barrel bushing, but in Plug Drills and Hand Facers this lower end of the barrel is not removable, and the only cure for it is to send it into the shop and have the barrel and this lower hole lapped out concentrically, one with the other, and have the piston made with a tit to accurately fit the hole. In the case of a Surfacing Tool it is simply a renewal of the barrel bushing that is required and often times the old piston can be used, as frequently the wear occurs more on the barrel bushing than it does on the piston, so that while the barrel bushing may be worn to such an extent that the tool is practically down and out, the tit of the piston may be very close to standard size.

In Plug Drills this difficulty may sometimes be practically remedied by a new piston, as the tit of the old one may be badly worn and a new piston of standard size may reduce the leakage at this point so as to make it for a time a very good working tool, but the proper way is to send it to the shop and have a new piston fitted to the relapped barrel.

To obtain a smooth running Pneumatic Tool it is necessary to properly proportion the amount of air which is allowed to flow to the bottom end of the barrel during the upward stroke of the piston, and this proportioning is obtained by the size of the port or passage leading from the valve box to the lower end. If too little air is admitted, that is, if too small a hole is used, the action of the tool will be slow and sluggish, due to its not obtaining a sufficiency of air or enough pressure at the bottom to raise the piston quickly, and if the hole is too large and too much air is admitted, in the case of Plug Drills and Hand Facers, it will result in a very rough running tool with excessive vibration, while in Surfacing Tools the piston will strike and damage the value box.

This is a lengthy matter to go into and probably would not be very interesting from a practical standpoint, and the only reason we are mentioning it is to illustrate why this wear of the tit of the piston and lower end of the barrel so seriously affects the efficiency of a tool.

Of course, when the tool is new a considerable margin, or as much as is permissible, is allowed in the way of admittance of air to the lower end, so as to counter-balance considerable of the wear, but as the tit of the piston or barrel bushing wears, the leakage becomes such that the port which was properly proportioned when the tool was new, is no longer able to furnish a sufficient amount of air to raise the piston to the top of the barrel. The conseuence is that the stroke of the piston becomes shorter and its upward movement slower, until in the end the leakage becomes so great that the port is no longer able to furnish sufficient air to perform its function.

As an illustration of what this leakage amounts to, we can take for example the large Surfacing Machine tool, the piston of which has a tit 1¾" in diameter. When the tool is new, the tit of the piston is practically an air tight fit in the bottom, or in the barrel bushing, but let the difference in diameter between the tit and barrel bushing be say two thousandths of an inch, this area, taking it around the circumference of the tit will amount to the same area as a hole ⅛" in diameter, so that you can readily see that in addition to the falling off in efficiency of the tool, you are also wasting air which would flow through an opening ⅛" in diameter during one-half of the time of the operation of the tool, and which in horse power at 80-lb. pressure would amount to practically 2 horse power, or 12 cu. ft. free air per minute.

The same conditions which we have mentioned regarding wear at the lower end of the piston also applies to the valve, but in a smaller degree. Of course, this wear of the valve will in time effect the tool in exactly a similar manner as that of the piston, but the lower end of the tool is more important inasmuch as it is there that the greatest wear and consequent leakage occur.

One extremely important point in the operation of all valve tools is that of keeping the tool tight. A Hand Facer, Plug Drill or Surfacing Macine Tool should never be operated for a minute after it becomes loose, but should instantly be taken to the repair shop and tightened, or in the case of a Surfacer Tool, time taken to tighten up the clamping bolts. One day's operation of any of these tools running loose will do more damage and harm than three months' use under proper conditions.

Plug Drills should not be run for a single moment without a bit inserted on which the piston may strike. This is the principal reason why a Plug Drill is not suitable, and should not be used for bushing purposes, or for such work as the Bumper or Hand Facer is commonly used. The reasons for this are as follows:—A Plug Drill in order to be efficient as a Plug Drill has a heavy piston and is not provided with a great amount of air cushion at the bottom end, so that when it is operated under conditions where the piston does not strike the chisel, as in the case of bushing, for it is simply impossible to do bushing work without the tool is operating for a considerable portion of the time when the piston is not striking the end of the chisel, the piston of a Plug Drill will in this case hammer the bottom of the barrel and it will not take long to so injure it or upset it that the tool will be in need of repairs.

In a Hand Facer this is overcome by using a lighter piston and more air cushion at the bottom, so that even though these tools are operated without a chisel or bit, the piston does not strike the lower end of the barrel with sufficient force to do any damage. It is for this very reason also that while a Hand Facer will do plug drilling, it will not do it with the efficiency and speed of a Plug Drill.

A Plug Drill piston, if it is allowed to strike the bottom of the barrel for any length of time, will, as mentioned above, not only injure the barrel, but it will take but a very short period for the piston to crystalize at the lower shoulder where it strikes the barrel, causing the piston to break at this point, and it will also be found that under these conditions it is almost impossible to keep the drill tight and in proper running order.

These same points come up in the operation of a Surfacing Machine. A Surfacer Tool should not be allowed to operate under these conditions any more than a Plug Drill, as aside from the crystalization sure to occur in the barrel and piston, this crystalization will also show its effects in the matter of the bolts, clamps, and even in the carriage itself. Many operators of Surfacing Machines are careless in this respect, and a very large portion of the breakages of bolts and clamps are due to this very reason.

Oil is as much a necessity, or more so, in these tools as it is in Carving Tools, due to the much larger wearing surfaces and the higher duty they have to perform.

In regard to repairs when necessary on Pneumatic Tools, it is always advisable to send the entire tool to the shop. For instance, when a valve box is sent in for repairs the factory can only put that particular part in a condition approaching as near as possible to that which it was in when new, but if the factory has the entire tool, it can, when this part is repaired, give the tool a thorough test and determine whether it is O. K. before sending it back. The fact that the parts of a Pneumatic Tool are not independent of each other, but the operation of each depends upon the action of some other part, renders this course necessary in order to have the repairs properly made and satisfaction in the operation of repaired tools guaranteed.

Take as an illustration a Surfacing Tool that has been running loose. The effect in this case is for the valve box to hammer on the top of the barrel, defacing both the valve box and the upper end of the barrel, which point should be and must be air tight. If only the valve box is sent in, it is useless for the factory to grind and refinish the face which comes in contact with the barrel, as not having the barrel to refinish and regrind also, the condition as regards leakage at this point would be as bad, if not worse than it was before.

It is poor economy to operate a Pneumatic Tool as long as it will run or make a noise, as the moment a tool begins to lose in efficiency

(*Concluded on page* 6628.)

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EVERYTHING PNEUMATIC

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EMANCIPATION OF MUSCLE BENEFITS ALL

When an efficiency engineer undertakes to raise the standard of performance in a manufacturing establishment he generally finds that he has to distinguish between the things which ought to be better done and those things which ought not to be done at all, at least in the way in which he usually meets them. Time studies of machining operations enable the most efficient rates for the different kinds of work to be determined and permits the introduction of methods intended to bring the efficiency of the entire force up to a close approximation to the determined maximum, with beneficial results to both workman and employer. Changes in the arrangement of work, in the sequence of operations, and in the general planning of the manufacturing end of the business—all these enter into the things in which improvement may be sought. There is one thing, however, in which no effort at improvement should be attempted, and that is in the use of human muscle to lift heavy loads. A man is provided with strength to do things which need immediate attention, directed by individual skill, under proper training and the exercise of brains; but to use this physical strength simply to overcome the force of gravity, as a regular occupation, is one of the things which the efficiency engineer should endeavor to abolish.

It is interesting to note that a continually improving department of engineering work lies in the production of mechanical appliances to this very end. An examination of almost any modern machine shop or foundry will reveal a marked diminution in the number of men whose work is simply to lift and move things about. The labouring gang, formerly very much in evidence, has been replaced by the traveling crane, by the industrial railway, and especially by the overhead tramrail, carrying some type of power hoist.

When the tramrail was first introduced it was employed, as its name indicates, to provide principally a means of enabling a load to be carried about, the lifting being effected by some form of hand hoist. The ease with which power could be applied to such lifting machinery, however, has widely extended its scope, so that in any shop in which compressed air, for example—and there are few modern shops in which this valuable auxiliary is not now used—an air hoist may be used to such advantage as to render manual labour almost wholly unnecessary for lifting purposes. It is in such methods that some of the most effective developments of efficiency will be found; and when efficiency is understood in its most intelligible definition, that of the reduction of wastes, and applied especially to the reduction of the waste of human energy, the highest returns may be expected. This means that the wasteful human energy should be replaced, so far as possible, by more efficient means.

It has been said that one of the chief characteristics of the coming epoch is that resulting from the manufacture of power, but to this must be included the effective transmission of power to points where it can be used in machines of maximum effectiveness. For this element in the work there is always an opportunity for the use of compressed air, and it is this which drills holes, fills them with rivets, brings the material to the points where it is to be worked, erected and secured; so that the present availability of power in the stored form of compressed air renders some of the most efficient tools of modern work possible.

By the use of such available power the work, not only of lifting loads, but of using the load which is lifted at the point desired at the moment it is wanted, enables the inefficiency of man's muscle to be replaced by the high efficiency of his judgment, and the result is appearing both in the mechanic and in the results of his work.

TOO BAD TO BE TRUE

In a paper upon Lublication read before the West Virginia Mining Institute by L. A. Christian, and printed in whole or in part in various papers, the following occurs:

"At a plant in W. Va. there was an air compressor with one cylinder 24"×26½"/40", guaranteed to compress 1,444 cubic feet of free air per minute with 90 revolutions per minute. This machine worked satisfactorily for about 11 months, then the capacity fell to about 900 cubic feet of free air per minute. On examination it was found that 11 out of 28 discharge valves were incrusted with carbon scale, and that they were stuck and partly open. When the valve caps were taken off the valves were found stuck so fast it was necessary to take off the cylinder head. Then by taking a round piece of hard wood large enough to cover the face of the valve they were driven out of the valve seats. It took four men over four days to get this machine in proper working order. The manager was anxious to know what caused the valves to stick and where the carbon scale came from. When asked what kind of air-cylinder lubricant was being used, his answer was that he was using an 18 cents per gallon engine oil. To get a proper lubrication, that oil was fed through a sight-feed lubricator at the rate of from 5 to 10 drops per minute. It was thought any kind of oil would do. If this company had used a good non-carbonizing oil from the time the machine was put in operation it would have saved nearly a hundred dollars."

We often hear the expression "too good to be true," and there can be little doubt that many times when it is used it aptly applies. There are occasions when "too bad to be true" would apply, and it is not apparent why we should not be as ready to use the one as the other when it will fit the case. If the discharge valves had been stuck as described the compressor would not have delivered any air at all against any customary pressure.

The necessity of using as little oil as possible for air cylinder lubrication, and then of periodically and systematically cleaning the valves and the cylinder interior generally cannot be too much insisted upon, but exaggeration of statement will not help the case.

LONG WATER TUNNEL IN BRAZIL

In the State of Rio, about seventy miles from Rio de Janeiro, there is under construction a water tunnel 4 meters (13 feet) by 4 meters in section which should attract attention, especially on account of its length. It is being built by the Rio de Janeiro Tramway, Light and Power Company, Limited, to carry water from an adjacent water shed to their present reservoir to increase their supply of water and to keep up with the electrical demand of the growing city of Rio. For the present information we are indebted to Mr. D. H. Campbell, Superintendent.

The tunnel is to be 27,650 feet (5¼ miles) long, grade .0023, with two angles in alignment to take advantage of the topographical conditions, one of 57 minutes, the other of 18 degrees 4 minutes. Four shafts and the ends afford ten points of attack, the depths of the shafts ranging from 218 to 375 feet, and at the present writing these are all completed.

A concrete dam 50 feet in height across the Pirahy river is also under construction and a diversion for this river to the tunnel.

The tunnel driving equipment comprises Ingersoll-Rand belt driven compressors, Ingersoll-Rand, Type E 44 Air Drills, Leyner Drill Sharpeners, Root Pressure Blowers and Baldwin Electric Locomotives, all driven from 3 phase, alternating current, transformed from 25,000 volts to 440 volts. The 25,000 volt line is carried 30 miles to the tunnel work from the company's power plant at Fontes.

The labor employed is Spanish, Italian, Portugese and English; the administration is American. Three 8-hour shifts are worked, and a bonus is paid for all progress over 3 meters per day at the rate of 125 Milreis (about $42 in gold) per lineal meter, divided among the three shifts in proportion to the rates of wages.

There are good opportunities on this work for experienced camp foremen and shift bosses who speak English and any Latin language. The labor as a class is good. The climate is healthful, and with 1200 men at work there have been no cases of fever or contagious diseases. Brazil has enormous undeveloped resources, and the success of an American company in developing power, light and traction facilities is indicative of future opportunities and much construction work in various lines.

PIECE WORK

There are many things to be said concerning the advantages of piece work over day labor. With piece work a man's ability is accurately known. The men will not only apply all their skill in doing the work but they will improve their output and learn better and more efficient methods of handling their tools, so that they may work them up to greater capacity. The output can be increased and also better work turned out if the same kind of work is always given to the same man, as men constantly employed on the same kind of work will become more efficient. Cutting piece-work prices shows great ignorance and inexperience on the part of a piece-rate man. It is a sign when some men make more money on their piece-work that they are taking an interest in their work and are hustling and working more efficiently. If their work is done properly they deserve all the money they can make. The chances are if another man was put at the same work he would not be able to make half as much. A man should understand that the price set on a piece of work is satisfactory to the employer, provided, of course, that it has been set properly in the first place, and that what the employer wants first of all is production. It pays the employer to treat the men with consideration and investigate their complaints, if any are made, and it may be necessary at times to raise a price to take care of certain unforeseen conditions on account of the hundreds of little things which have to be considered. If everything is given proper consideration there is no reason why the straight piece-work system should not be looked upon with favor by the employee, since through it he can make more money.—*T. F. Keane before the Master Blacksmiths' Association.*

THE FLOW OF PEOPLE

The following, which should be especially suggestive to the readers of Compressed Air Magazine appears in an editorial department of a recent issue of Cassier's Magazine.

There is probably no one problem in engineering which has demanded and received more attention than that involving the proportions and construction of channels and conduits for the conveying of fluids of various kinds from one point to another. For three hundred years and more the flow of water in channels and pipes has been studied, and every detail of surface friction, eddy resistance, internal work, and mean velocity has been examined theoretically and practically. In like manner the flow of air and of gases has been investigated, and it is practicable, with the information available and tabulated, for almost any engineer to compute the capacity of a given system of piping, or to plan a combination of channels to meet definite requirements. When several pipes are intended to deliver their contents into a main collector, the rules for proportioning the various sections are readily applied so that there shall be no undue obstruction to the flow, and the several velocities may be combined in a manner which permits the least practicable resistance to be imposed upon the movement of the entire mass.

These facts are so well known and so generally appreciated that any discussion of them in this place may seem so elementary as to be unnecessary, but it is the very completeness of our knowledge relating to the mechanical flow of inanimate substances which renders almost inexplicable the lack of practical application of the same principles to the flow of human individuals. A fluid is nothing more than an aggregation of molecules capable of a certain degree of mobility among themselves, and it will take a very moderate amount of observation of a mass of people to render it clear that such a crowd is subject to laws similar to those governing the motion of steam, water, or air. If a crowd of people approaching and passing through a narrow entrance be observed from above, it will be distinctly apparent that the flow of the human particles is almost identical in character with that, for example, of sand through the contraction of an hour glass. If such a crowd, while waiting, has a center of disturbance created within it, the concentric waves of agitated humanity will be perceived extending far beyond the cause of movement or beyond the direct knowledge of the human molecules.

Under such circumstances it is most curious that more attention has not been given to the laws governing the flow of people, in connection with the proportioning of streets, passages and various conduits through which the great currents of humanity are compelled to pass, and it is one of the educational problems of the immediate future to instruct engineers, architects and administrators in the important matter of the avoidance of artificial congestion, by providing rationally designed routes of travel.

At the present time there appears to be a surprisingly small amount of reliable information available upon the subject. How many architects know the capacity of a staircase, or the possibilities of a doorway, in terms of a definite flow of people in a given period of time?

What is the resistance of a certain contraction in a passage, or the frictional opposition of a sharp corner or a projecting buttress? Probably the builders of passenger elevators are in possession of experimental data concerning the capacity of such machines, but such information is sufficiently valuable to be kept for the use of those who have been wise enough to acquire it. These and similar points must soon become essential in the development of the city, the railway station, and the public building of any kind, and it is extremely probable that the greater the degree of fullness with which the information is secured, the closer the laws will be found to approximate those already ascertained for inanimate fluids.

One thing is evident, at least, the basic principle of efficiency in the movement of people, as with other things, will be found to lie in the maintenance of continuity of flow. Any interruption or any marked check to flow introduces such a degree of loss as to render it most undesirable, and in most instances a moderate average rate of flow, if uninterrupted, will provide a much greater capacity than an intermission of stoppages and spurts of high speed. The time is ripe for a study of the flow of people, and it is a problem of vast interest, both to the engineer, by whom it must be directed, and to the people themselves, who are even more closely concerned.

USE AND ABUSE OF PUNEUMATIC TOOLS

(*Concluded from page* 6624.)

and cutting power, you are not only using more air, which is an insignificant item comparatively speaking, but you are really wasting the time of a high-priced man in operating this tool. It is a very easy matter to lower a man's efficiency by 25 per cent. in using a tool that should have gone to the repair shop some time previous.

While this paper is prepared with a view of touching on Pneumatic Tools only, we have seen so many instances of bad practice in regard to the installation and operation of Air Compressors that we feel that a few words will not be out of place.

We urgently recommend that in all plants particular attention be paid to the intake of the air compressor. Air should never be taken from a room where stone-cutting is being done as the air is filled with fine particles of grit, which are, in cases of this kind, constantly drawn into the Compressor and forced through the tools, with a consequent continuous grinding or cutting action. The ideal arrangement for a compressor intake pipe is to run it out through the roof of the shed and enclose the end of it in a framework two or three feet square covered with a couple of thicknesses of fine muslin.

When the plant is being installed, nothing but new clean pipe should be used for conveying air to the tools. Every piece of pipe should be stood on end and hammered to jar loose any scale that may be on the inside, and every fitting should be inspected to see that it is perfectly clean. If old rusty pipes and fittings are used, you will have endless trouble and annoyance from dirt and scale coming through the pipes and hose to your tools. These precautions will give a supply of cool, clean air, and the effective working life of the plant will be increased 100 per cent. over what it will be if installed and operated in the slipshod, slovenly manner that many plants are.—*Granite, Marble and Bronze.*

TO BLOW ITSELF ALONG

The recent successful application of a propeller working in the air as a means of propulsion both for a road vehicle and for a canal barge has been followed by some interesting experiments by French officers in Algiers with a kind of sledge mounted on six wheels, driven by a 50-horsepower motor, and similarly equipped with a propeller. This vehicle, which carries three persons, travels easily over the rolling sand at a speed of 12 to 18 miles an hour, and is said to be able to climb gradients of one in five. It is believed that this new means of transport will solve many of the difficulties of communication in the Sahara, and it is hoped by fitting it with wings not only to facilitate its progress, but to enable it on occasion to leap over obstacles in its path.

NOTES

The cranks whose senseless agitation has eliminated the public drinking cup, even in Pullman cars, have inflicted much discomfort upon ordinary people and have largely increased the business of saloon keepers. The victims that deserve the greatest pity are the poor immigrant children who have need to make long journeys in hot dusty cars. When this pernicious movement against free water drinking has passed, people will wonder at the blindness which enabled cranks and saloon keepers to spread so much discomfort among honest people.—*R. & L. Engineering.*

At the Cinderilla Consolidated mine, on the Rand, large quantities of sand are sent down for filling. At first attempts were made to send the sand down wet in pipes, but owing to the wear of the pipes, and the great cost of pumping 4000 ft., this method was abandoned. The sand is now sent down dry through a wooden shute about 12 in. square, and jets of compressed air are used at the bends to assist.

A hydrogen pipe line has been built in Germany, to carry hydrogen from a chemical works to the dirigible-airship station, near Frankfort. The pipe line is about three miles long, and is operated under a pressure of about 40 in. of water. Nearly the whole of the line is welded, couplings being used at long intervals only.

The first shaft to be put down by the freezing process was the Archibald Lignite Colliery, at Schneidlungen, Germany, in 1883. Until quite recently, sinking to a depth of from 300 to 500 ft. has been regarded as something extraordinary, but a German shaft has been successfully put down to a depth of 990 ft., about 820 ft. of which was quicksand and thin beds of sandy clay. There are now other shafts in the course of sinking by this method that will be nearly 1500 ft. in depth.

Prof. Willis L. Moore, chief of the Weather Bureau, speaking on "The Story of the Air," said that the floods of the Mississippi were not due to the cutting down of the forests, but to air conditions. "As long as we have the Gulf of Mexico to the south of us," said Chief Moore, "we shall have floods, because the warm air coming up from the Gulf, meeting the cooler air from the north, causes condensation and rain."

Works are now about completed at Alexandria, near Sydney, New South Wales, by the British Oxygen Company, Limited, London, for the production of pure oxygen by the liquid air process. The present plant—which is considered a small one—produces 17,000 cubic feet of oxygen per day. The plant is driven by a Diesel engine, which develops from 80 to 100 brake horse power, the engine being placed about the middle of the machinery. Air is compressed by a four-stage, belt-driven compressor.

Experiments made with a view to bringing aluminium to a liquid condition capable of being spread when cold over any dry surface, have, according to statements in the German press, been crowned with success. The composition is applied like paint with a brush, and gives an appearance similar to dull silver coating. It is said to be an excellent rust preventive, possessing resistance to heat up to 500 deg. Cent. It is also stated to be elastic, durable, proof against atmospheric influences, and a perfect substitute for tin in plating.

In the Transvaal mines, South Africa, according to the government mining engineer, in 1910 there were 257 compressors, with 100,291 hp. No separate returns of the value of air compressors were rendered to the department. The gold mines in the Johannesburg consular district employ on an average three 50-drill compressors on each mine for driving the drills. Up to about two years ago the air compressors were almost entirely driven by steam, but since then electric power has been furnished to nearly all of the mines, and steam power for air compressors has been superseded by electricity.

Cleaning water mains with mechanical scrapers at Halifax, has been responsible for a considerable increase in the hydrostatic pressure at hydrants. In a paper before the meeting of the Union of Canadian Municipalities on Aug. 28, Mr. F. W. Doane, City Engineer, stated that in one case the average pressure on 25 hydrants increased from 34.2 to 54.4 lb. per square inch as a result of cleaning. In another district there was a pressure of 19 lb. after cleaning where before there had been no water at all.

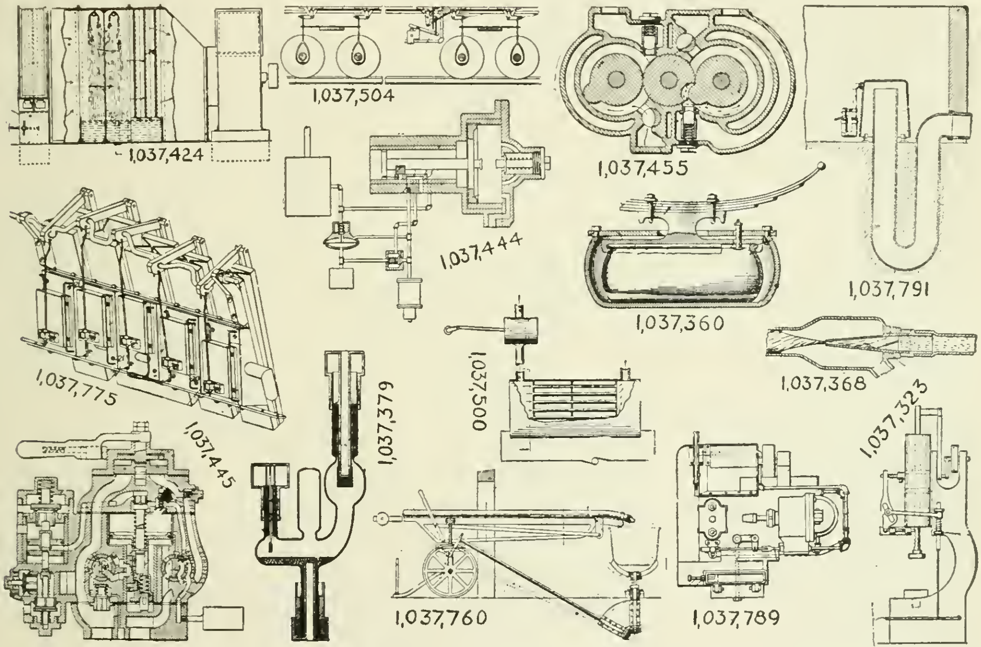
The greatest depth yet found in all the oceans was discovered recently by a surveying ship of the German navy about forty miles off the north coast of Mindanao, near the Philippines. Here soundings showed 9,780 meters or a depth of six miles plus 406 feet. The greatest depth heretofore known was a spot south of the Island of Guam, discovered in 1901 by the U. S. cable steamer Nero. Here a depth of 9,635 meters or a little less than six miles was found.

Need for a general knowledge of mineralogy by working miners was evidenced recently by the discovery of a 6-in. seam at the Lady Rose mine, Victoria, Australia. The miners regarded the material as worthless, since there was no indication of gold in it, and large quantities of it which had been broken were discarded as worthless. A visiting engineer recognized the material as scheelite, of remarkably good quality, worth $400 per ton, much more than the gold-bearing quartz the miners were seeking.

Another pit sinking record has been established in connection with the Doncaster, England, coalfield. On Saturday, September 14th, the sinkers employed at the new colliery being sunk at Askern Spa, near Doncaster, by the Askern Spa Coal and Iron Company, reached the Barnsley seam of coal at a depth of 565 yards. In No. 1 shaft the seam is 9 ft. thick and of excellent quality. Sinking was commenced only last December, so that the progress made has been remarkably rapid, the average having been 14 yards per week. Seventy-six yards of tubing had to be placed in each shaft to dam out 4000 gallons of water per minute.

A company (Det Norske Nitridaktieselskab), with $2,700,000 fully subscribed capital, has been formed in Christiania to produce sulphate of ammonia from the atmosphere after the method of an Austrian engineer, Dr. Serpek. The invention has been developed by a French company, Société Generale des Nitrures, and the patent right for Norway has been acquired by Det Norske Aktieselskab for Elektrokemisk Industri. The new company has been started jointly by French and Norwegian interests. Construction of the mill will commence immediately at Arendal, operations to start in the autumn of 1914. At first 10,000 hydroelectric horsepower will be used to be increased later to 25,000. The power will be supplied by A/S Arendals Fossekompani. The annual output is calculated to exceed 40,000 tons of sulphate ammonia.

A successful trial trip has been made by the first motor ship built at Kiel for trade between the east coast ports of North and South America. The vessel has a length of 350 feet, with a beam of 50 feet and a depth of 27 feet, but the chief interest lies in the fact that this is the first large cargo boat for trans-Atlantic trade to be fitted with two-cycle Diesel motors. Each of the two main engines has four cylinders with a bore of 18.5 inches and a stroke of 26.77 inches, and together develop about 2,000 indicated horsepower. They are of the crosshead type, and the air-compressors and scavenging pumps are driven directly off them, as also are the bilge, fuel, lubricating oil, and other pumps. In addition there are an air compressor and a dynamo, both driven by 50 horse-power Diesel engines, and a smaller dynamo worked by steam, which is supplied by an oil-fired boiler on deck. The deck machinery is driven by steam, which can also be used alternatively to compressed air for the steering gear.



Pneumatic Patents, September 3.

Milking machines, employed in New Zealand about four years ago, and since then much improved and developed in Australia, are coming into general use there, saving much time and labour for those engaged in dairying. The American Consul at Sydney says that demonstrations of these machines have been amongst the most interesting and popular features of agricultural shows in Australia, and he calls attention to several records of over one hundred cows being milked by these machines in less than two hours. The machines not only possessed the advantage of speed and economy, but also rendered the milking operation cleaner and more sanitary than when performed by hand. These machines are all made and worked on the natural principles of suction and compression, copying nature in the calf as closely as possible.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 3.

1,037,323. PNEUMATIC HAMMER. Griffith D. Roberts, Columbus, Wis.

1,037,360. PNEUMATIC SUPPORT FOR VEHICLES. Charles J. Stovel, San Francisco, Cal.

1,037,368. VACUUM-CLEANER. Edgar B. Symons, Milwaukee, Wis.

1,037,379. VACUUM APPARATUS. Ezechiel Weintraub, Lynn, Mass.

1,037,424. APPARATUS FOR PURIFYING AIR. William G. R. Braemer, Buffalo, N. Y.

1,037,444. MAINTAINING DEVICE FOR AIR-BRAKES. Murray Corrington, New York, N. Y.

1,037,445. FLUID-PRESSURE-BRAKE APPARATUS. Murray Corrington, New York, N. Y.

1,037,455. AIR-COMPRESSOR. Victor J. Diefenderfer, Allentown, Pa.

1,037,500. OZONIZER. Ross M. Leggett, Ann Arbor, Mich.

1,037,502. APPARATUS FOR LOCKING CAR-DOORS. Joseph B. Lowell, Everett, Mass.

1,037,504. AUTOMATIC TRAIN-STOP. James W. McKelvey, Lawrenceville, Ga.

1,037,535. FLUID-OPERATING TOOL. Charles B. Richards, Cleveland, Ohio.

1,037,548. APPARATUS FOR DRYING HAIR. Ida Scholz, Altena, Germany.

1. Apparatus for drying hair comprising in combination a hot water vessel for drying the hair from below and a second hollow vessel adjacent to said hot water vessel, means for driving a current of air through said second vessel,

and means for directing the thereby heated current of air on the hair on said vessel, substantially as set forth.

1,037,586. APPARATUS FOR COMPRESSING AIR AND OTHER FLUIDS. Ernst Birawer, Berlin, Germany.

1,037,760. SAND-BLASTING APPARATUS. Harvey B. Heaslet, New Brighton, Pa.

1,037,789. FLUE-EXPANDER. John Thos. McGrath, Battle Creek, Mich.

1,037,791. ADJUSTABLE VENT FOR SIPHONS. Samuel F. Miller, South Orange, N. J.

1,037,830. MACHINE FOR CEMENTING BRUSH-BRISTLES. Hugh P. McMillan, Baltimore, Md.

1. In a cementing apparatus the combination with means to clamp the work, of means for forming a seal about that part of the work where the cement is to be applied and traveling means movable along the clamped work for supplying air under pressure to the sealed portion of the work.

1,038,059. BRAKE-SHOE CONTROL. Luzian Zink, Detroit, Mich.

1,038,065. OXYGEN-GENERATOR. Newton J. Anderson, Coffeyville, Kans.

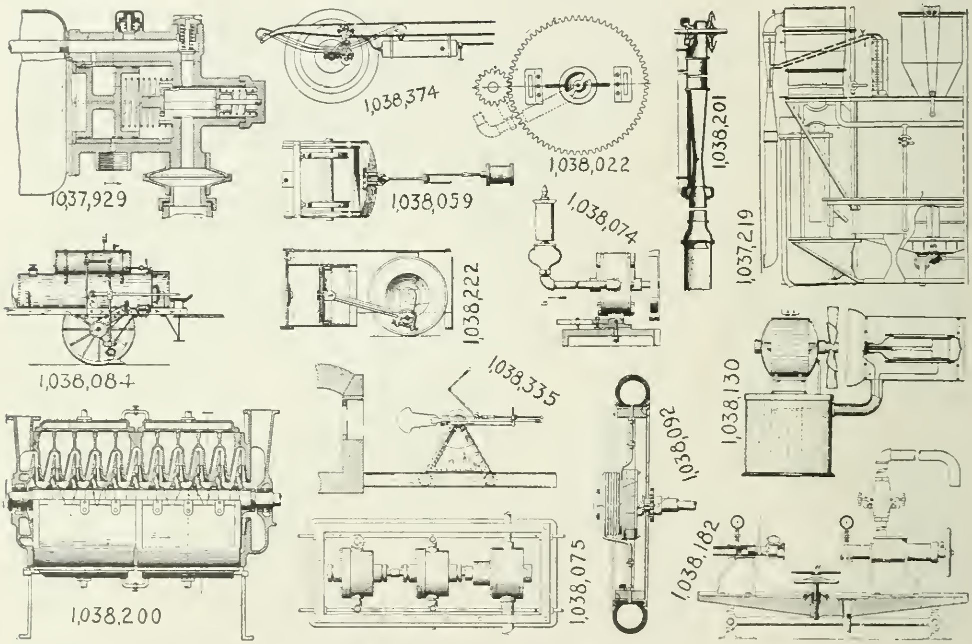
1,038,074. POWER-WHISTLE. Reinold Berrenberg, Boston, Mass.

1. A signaling device, comprising a base, a rotary air compressor pivotally mounted on said base and having a driving pulley, a power whistle connected to said air compressor, and a lever arranged to swing the air compressor about its pivot to bring its pulley into driving relation with a power operated wheel.

1,038,075. VACUUM-PUMP APPARATUS. Reinold Berrenberg, Boston, Mass.

1,038,084. APPARATUS FOR TREATING SOIL. Frank C. Carroll, Cleveland, Ohio.

In apparatus for treating the soil, in a vehicle, a solution tank mounted thereon, an air tank also mounted on said vehicle, means for supplying compressed air to said tank, an atomizer connected to the air tank and solution tank, a distributing device leading from said atomizer to a point near the ground, and a distributing tooth comprising a shank swiveled to the distributing pipe, an inclined upper portion, and a receiving chamber under said upper portion and provided with discharge openings adapted to direct the discharge in lateral inclined directions.



Pneumatic Patents, September 10.

SEPTEMBER 10.

1,037,894. HOT-AIR HEATER. John H. Garner, Kingwood, W. Va.

1,037,919. PROCESS OF MANUFACTURING HYDROGEN. George Francois Jaubert, Paris, France.

1,037,929. AIR-BRAKE VALVE. Jacob B. Knudsen, Chicago, Ill.

1,038,022. PNEUMATIC COOLING DEVICE. Herman T. Sundstrom, Houston, Tex.

1. A device of the character described including the combination with a disk having an air chamber in the face thereof, of molds carried by said disk, a plate secured upon said disk and covering said air chamber and having an aperature therethrough communicating with said chamber, air outlets leading from said chamber and discharging against the molds carried by said disk, and an inlet tube secured to said plate and communicating with the air chamber through the aperature therein.

1,038,049. SUCTION AND PRESSURE DREDGER. Pieter van Wienen, Cologne, Germany.

1,038,092. COOLING DEVICE FOR PNEUMATIC TIRES. Andrew B. Craig, Tarkio, Mo.

1,038,130. APPARATUS FOR PRODUCING OZONE. Siegfried Held, Chicago, Ill.

1,038,182. FLUID-METER TESTER. Philip Mueller, Decatur, Ill.

1,038,200. MEANS FOR COOLING TURBO COMPRESSORS OR BLOWERS. Auguste Camille Edmond Rateau, Paris, France.

1,038,201. MEANS FOR INCREASING THE HEIGHT OF SUCTION OF PUMPS. Auguste Camille Edmond Rateau, Paris, France.

1,038,222. PUMP FOR VACUUM-CLEANERS. Robert R. Smith, Philadelphia, Pa.

1,038,285. CAPSULE OR CONTAINER FOR COMPRESSED OR LIQUIFIED GASES. Robert Hunter Campbell, Edmonton, England.

1,038,335. MACHINE FOR BLOWING GLASS CYLINDERS. John Forster, St. Helens, England.

1,038,374. COMBINED AIR-COMPRESSOR AND SHOCK-ABSORBER. Joseph D. Jackson, Washington, Pa.

SEPTEMBER 17.

1,038,515. ATTACHMENT FOR STEAM-LOCOMOTIVES. Halstead T. Aydelott, Birmingham, Ala.

1. A locomotive attachment comprising a controller valve adapted to be located in the cab, means to supply fluid pressure to said valve, a blower pipe for the locomotive, a fluid pressure controlled valve for controlling the flow of fluid pressure to the blower pipe, separate fluid pressure pipe lines leading from said controller valve and adapted to deliver fluid pressure to operate respectively a bell ringer and said fluid pressure controlled valve, there being a port in the casing for said controller valve for each of said pipe lines, and there being ports in the movable member of the controller valve adapted to simultaneously control the fluid pressure conditions in said several pipe lines, as and for the purposes described.

1,038,521. PNEUMATIC ORE-STAMP. Hans Charles Behr, Johannesburg, Transvaal.

1. In a percussive apparatus the combination of a cylinder provided with an extension; a reservoir of compressed air in communication with said extension; a piston in said cylinder; a stamp head associated with said piston; means comprising an operating piston and cylinder whereby air of greater pressure than that in said reservoir may be delivered to one side of said piston; and means whereby the pressure on said side is prevented from remaining below that in said reservoir during the downward stroke, substantially as described.

1,038,524. GENERATOR OF HYDRAULIC POWER FOR PRESSES, &c. Albert T. Bossert, Kansas City, Mo.

1. In a generator of the character described, a low-pressure cylinder containing motive fluid, an intensifier cylinder containing motive fluid and arranged within the said low-pressure cylinder, a valve to admit pressure to the low-pressure cylinder to force fluid therefrom, an intensifier plunger to force the fluid from the intensifier cylinder, and means to conduct the motive fluid to the point of use.

1,038,624. PNEUMATIC DOOR-LOCK. John C. Messick, San Rafael, Cal.

1,038,691. APPARATUS FOR GENERATING HIGH-PRESSURE OIL-GAS. Rudolph Vuilleumier, New Rochelle, N. Y.

1. An apparatus adapted to produce high candle-power gas under high pressure, combining a generator, means for internally heating the same, a pre-heater, means for introducing oil through said pre-heater into said internally heated generator, means for removing the resultant fixed gases through said pre-heater, and means adapted to maintain throughout said apparatus a pressure of approximately fourteen atmospheres.

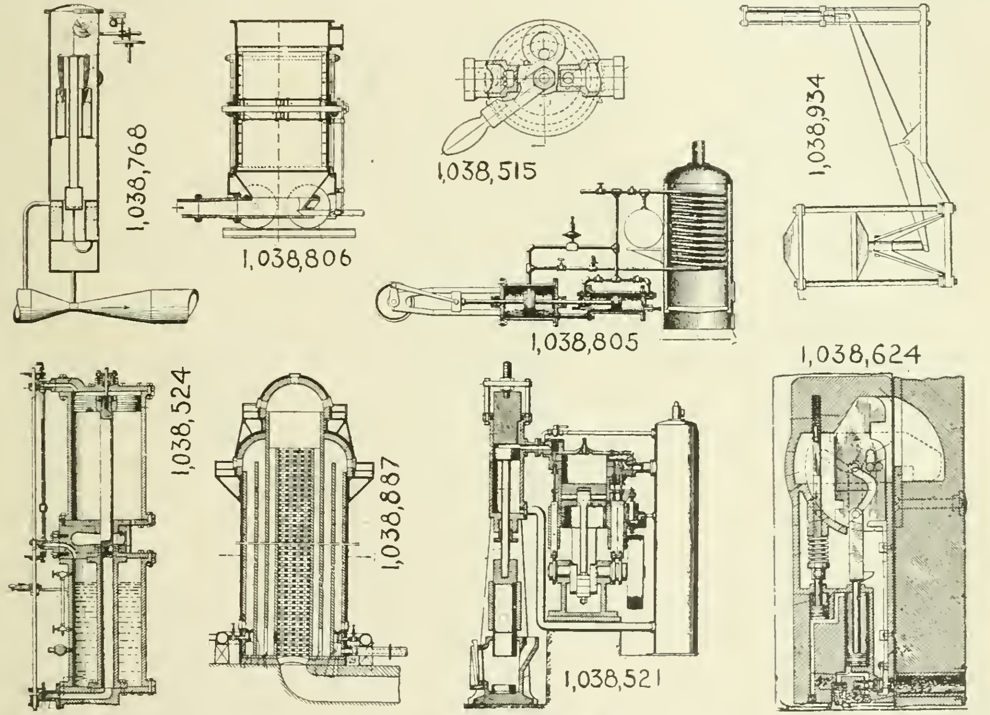
1,038,761. PNEUMATIC PIANO-PLAYER AND THE LIKE. Macarius Maximilian Kastner and Conrad Katz, London, England.

1,038,768. FLUID-METER. John W. Ledoux, Swarthmore, Pa.

1,038,781. SAND-BLAST. James C. Myles and Harold Girvin, San Francisco, Cal.

1,038,801. MEANS FOR INDICATING THE DEFLATION OF PNEUMATIC TIRES. Francis H. Treat, Cleveland, Ohio.

1,038,805. HOT-AIR ENGINE. Samuel J. Webb, Minden, La.; Robert D. Webb, Minden, La., by inheritance and by mesne assignments owner of entire title.

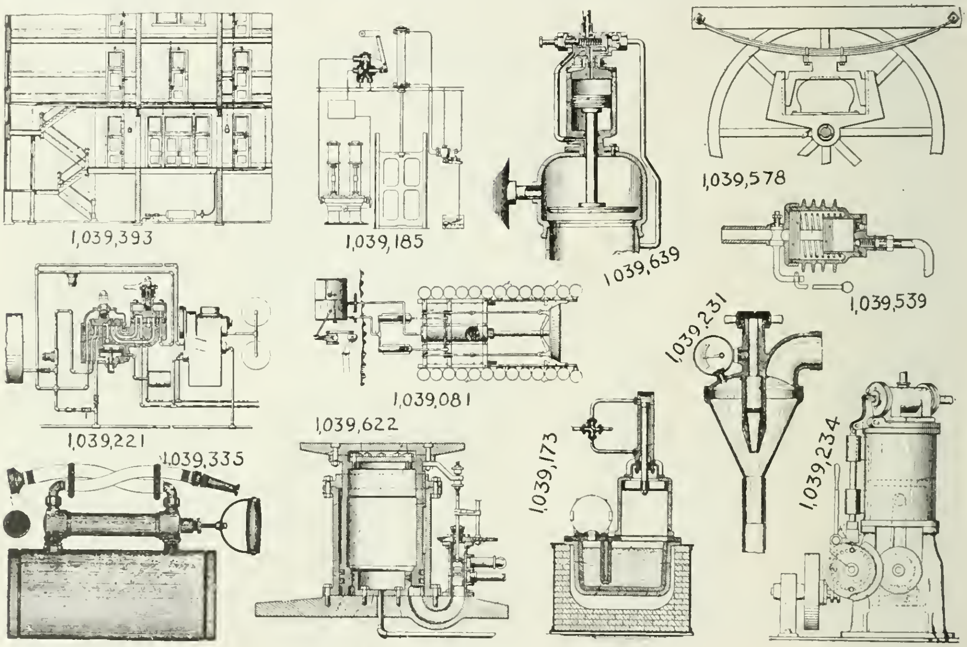


Pneumatic Patents, September 17.

1. In a hot air engine, the combination of an air compressor, a motor adapted to be operated by air compressed by the compressor, the latter connected to be operated by the motor, a conduit between the outlet of the compressor and the inlet port of the motor, means for heating the air passing through said conduit, and a bypass connection between the compressor and motor permitting the cold air when the pressure is excessive to pass between the compressor and motor without going through the heater, substantially as set forth.

1,038,806. APPARATUS FOR HANDLING CONCRETE. Rudolph Welcker, Yonkers, N. Y.

1. In an apparatus for handling concrete and the like, the combination of an air tight casing having side walls sloping downwardly and inwardly and terminating in an elongated channel extending lengthwise of the bottom of the casing; an outlet conduit at the exit end of the channel; an air supply pipe at the rear end of the channel and so disposed as to deliver a blast of air lengthwise of the channel; and means above the sloping walls for dropping small masses of concrete upon said walls for direction thereby into said blast of air.



Pneumatic Patents, September 24.

1,038,887. AIR-BLAST HEATER. Edmund Hohmann, Stettin, Germany.

1,038,934. COTTON-COMPRESS. Marshall M. Mode, Cameron, Tex.

SEPTEMBER 24.

1,039,081. WAVE-MOTOR. Francis C. Bates, San Jose, Cal.

1,039,148-9. APPARATUS FOR REFRIGERATING AND DRYING GASES. Charles H. Leinert, Chicago, Ill.

1,039,173. PRESSURE CASTING APPARATUS. Albert Wood Morris, Philadelphia, Pa.

1,039,185. FLUID-PRESSURE APPARATUS FOR OPERATING BULKHEAD AND OTHER DOORS. Frederic John Pike, Beckenham, and Herbert Neville, Forest Hill, England.

1,039,209. VACUUM CISTERN-CLEANER. Howard Stucker, Shawnee, Okla.

1,039,221. LOCOMOTIVE-BRAKE. Walter V. Turner, Edgewood, Pa.

1,039,222. BRAKE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,039,231. NOZZLE FOR APPARATUS FOR EXHAUSTING, PROPELLING AND INDUCING CURRENTS IN FLUIDS. Gottfried Weidmann, Zollikon, near Zurich, Switzerland.

1,039,234. PRESSURE CASTING APPARATUS. Samuel Price Wetherell, Jr., and Albert Wood Morris, Philadelphia, Pa.

1,039,243. STERILIZER. Robert P. Barnstead, Boston, Mass.

1,039,264. PNEUMATIC BLOW-OUT FOR ELECTRIC SWITCHES. Edward H. Dewson, New York, N. Y.

1,039,335. AUTOMATIC SPRAYING APPARATUS. Aaron J. Tyler, Rochester, N. Y.

1,039,393. DOOR-OPERATING MECHANISM. Thomas J. Heron, Pittsburgh, Pa.

1. Door mechanism of the character described, comprising a system of pressure pipes or conduits having branches extending to the different doors to be opened, means for normally supplying pressure to said pipes or conduits, means for effecting a reduction of said pressure from any one of a number of different points, and door opening devices rendered operative by such reduction of pressure; substantially as described.

1,039,537. PNEUMATIC CUSHION. Josef Hofmann, Baumaroche, Switzerland.

1,039,539. AUTOMATIC COMPRESSOR-PUMP. Alfred Jaekel, Paris, France.

1,039,578. PNEUMATIC SPRING. Thomas J. Mullen and Thomas F. Brennan, New Brighton, N. Y.

1,039,622. MACHINE FOR JARRING SAND MOLDS. Edgar Clarence Wiley, Lynchburg, Va.

1,039,639. FLUID-PRESSURE REGULATOR. John J. Bodwin, McKeesport, Pa.

1,039,678. VALVE MECHANISM FOR JARRING-MACHINES. Edgar C. Wiley, Lynchburg, Va.

COMPRESSED AIR

MAGAZINE

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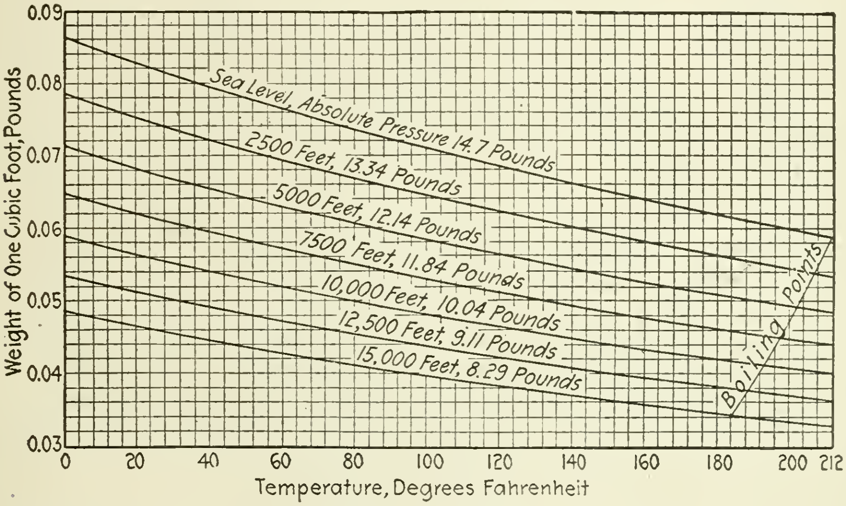


FREE AIR BY WEIGHT.

COMPRESSED AIR BY THE POUND

BY FRANK RICHARDS.

In statements and computations having to do with the compression and transmission of air the basis or unit of quantity is the volume, usually in cubic feet, of free air, or air at atmospheric pressure, at the time and place under consideration. There are some inconveniences and uncertainties about this practice because the value of the unit is constantly varying with both the altitude, or normal local pressure, and with the temperature. This working volume can always be compared with what would be the volume at sea level and at average temperature, say 60 deg. F., but it is an unwelcome operation.

Knowing the actual quantity of air handled at any time and place would be working with more certainty. If the actual weight of the air is known, it remains the same, whatever the transformations of condition. Pressure, volume and temperature may all vary, but "a pound's a pound for a' that."

To facilitate using the weight basis for records and computations the accompanying table and diagram have been prepared. Computing the items of this table was simple. The weight of a cubic foot of air, whether compressed or not, is obtained by multiplying the constant 2.7093 by the absolute pressure and dividing the product by the absolute temperature. Thus the weight of 1 cu. ft. of air at an altitude of 10,000 ft. (absolute pressure 10.04 lb.) at 80 degree F. is

$$\frac{2.7093 \times 10.04}{80 + 461} = 0.0502 \textit{ lb.}$$

The diagram embodies all the data com-

WEIGHT OF 1 CU.FT. OF FREE AIR AT VARIOUS ALTITUDES AND TEMPERATURES.

Temperature Fahr.	Sea level Abs. press. 14.72	2500 ft. Abs. press. 13.34	5000 ft. Abs. press. 12.14	7500 ft. Abs. press. 11.84	10,000 ft. Abs. press. 10.04	12,500 ft. Abs. press. 9.11	15,000 ft. Abs. press. 8.29
0	0.0863	0.0785	0.0713	0.0648	0.0589	0.0535	0.0487
10	0.0845	0.0768	0.0698	0.0635	0.0577	0.0524	0.0477
20	0.0827	0.0752	0.0683	0.0622	0.0565	0.0513	0.0467
30	0.0811	0.0737	0.0669	0.0609	0.0554	0.0503	0.0457
32	0.0807	0.0734	0.0667	0.0606	0.0551	0.0501	0.0455
40	0.0794	0.0722	0.0656	0.0596	0.0542	0.0493	0.0448
50	0.0779	0.0708	0.0643	0.0585	0.0532	0.0483	0.0439
60	0.0764	0.0695	0.0631	0.0574	0.0522	0.0473	0.0431
70	0.0750	0.0682	0.0619	0.0563	0.0512	0.0465	0.0423
80	0.0736	0.0669	0.0608	0.0552	0.0502	0.0456	0.0415
90	0.0723	0.0657	0.0596	0.0542	0.0493	0.0448	0.0408
100	0.0710	0.0645	0.0586	0.0533	0.0484	0.0440	0.0400
110	0.0697	0.0634	0.0578	0.0523	0.0476	0.0432	0.0393
120	0.0685	0.0623	0.0565	0.0514	0.0466	0.0424	0.0386
130	0.0674	0.0612	0.0556	0.0506	0.0459	0.0417	0.0378
140	0.0662	0.0602	0.0549	0.0497	0.0452	0.0410	0.0373
150	0.0651	0.0592	0.0538	0.0489	0.0444	0.0404	0.0367
160	0.0641	0.0583	0.0529	0.0481	0.0438	0.0397	0.0361
170	0.0634	0.0573	0.0521	0.0473	0.0431	0.0391	0.0358
180	0.0621	0.0565	0.0513	0.0466	0.0424	0.0383	0.0348
190	0.0612	0.0556	0.0504	0.0459	0.0417	0.0379	0.0343
200	0.0602	0.0547	0.0497	0.0452	0.0411	0.0373	0.0338
210	0.0593	0.0539	0.0489	0.0445	0.0405	0.0368	0.0332
212	0.0591	0.0538	0.0488	0.0444	0.0404	0.0366	0.0331

prised in the table, while the curve at the right hand, where it cuts the altitude curves, gives the boiling points of water at those altitudes.

The diagram shows at a glance the difference in weight, or in the actual quantity of air handled, at the different elevations. Thus, to take the extremes, the weight of a cubic foot of free air at sea level and at 60 deg. is 0.0764 lb., while at an elevation of 15,000 ft. the weight of the same volume and at the same temperature is 0.0431, this latter being only 56 per cent. of the former.

In compressing this air to say 100 lb. local gage pressure, the compression at sea level would be $(100 + 14.7) \div 14.7 = 7.8$ atmospheres or compressions, while at 15,000 feet it would be $(100 + 8.29) \div 8.29 = 13.06$ atmospheres or compressions. This at once suggests the greater desirability of two-stage compression at the higher elevation.—*Power.*

MEASURING THE FLOW OF AIR IN PIPES

BY G. G. CREWSON.

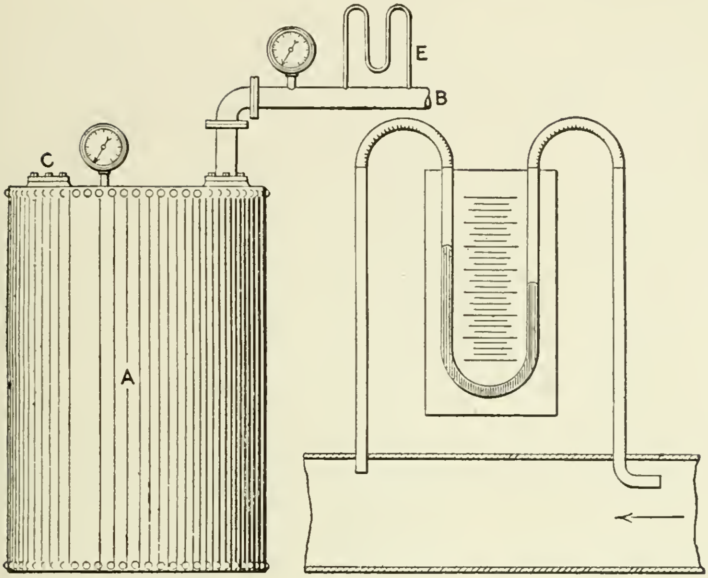
Some time ago, in a large mill where it was desired to make a proper cost distribution for the compressed air supplied to the various departments, the problem arose of measuring the air velocities in the different pipes. These velocities varied from 500 to 5,000 ft. per minute with the air under a pressure of about 80 lb. per square inch and as dry as can be obtained in a large compressed-air system.

The pitot tube was considered to be the most convenient device for the purpose, and in order to determine the accuracy of the various arrangements, an apparatus was fitted up as shown in Fig. 1. The air was admitted to the large tank *A* through the pipe *B* and escaped through an orifice at *C*. Pressure gages showed the pressures at the pitot-tube connection *E* and at the discharge orifice. Different-sized orifices were used in each case, these having previously been calibrated and the flow per minute under a tank pressure of 80 lb, per square inch was determined as follows:

Diameter of orifice, inch	Cu. ft. of air per min.
⅜	191
½	340
⅝	532
¾	765

The pitot tube was inserted in the supply pipe at a point not less than 20 diameters away from the tank or from any bend or fitting in the pipe that would tend to cause eddy currents. Various sizes of supply pipes were also used.

The two sides of the pitot tube led to an ordinary form of U-tube, and at first this feature was troublesome as difficulty was experi-



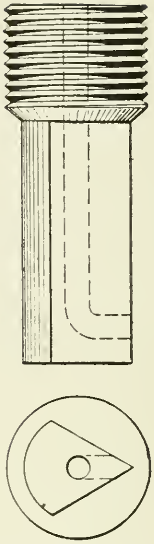


Fig. 1. Arrangement of Apparatus

Fig. 2. First Form of Pitot Tube Used

Fig. 3. Final Form of Velocity Tube

enced in maintaining tight connections. This was finally overcome to a large extent by making a special form of U-tube with well packed connections and leads of ⅛-in. pipe.

The form of pitot tube first employed was but a piece of ⅛-in. brass pipe bent as shown in Fig. 2. The pressure side extended slightly inside the wall of the supply pipe. This form proved very unsatisfactory, giving varying results for the same conditions.

The next change was to make the velocity tube a straight pipe instead of a bent one. This projected directly into the supply pipe and was plugged at the end with a ⅛-in. hole drilled in the side facing the flow. The results in this case were but little better than before. The opening was then changed to $^1/_{16}$ in, without materially affecting the observations.

Many modifications were made in the form of pitot tube used until the one shown in Fig. 3 was adopted. This tube was brass, turned and threaded to correspond to a ⅛-in. standard pipe to the point where it screws inside of the air pipe. Within the air pipe it has the form of a wedge with a knife-edge, the edge facing the flow, hence offering little resistance. The opening through the tube and the outlet facing the flow were $^1/_{16}$ in. in diameter.

These tubes were made in a number of different lengths for different sizes of pipe in order that the opening at the edge might always be near the center of the pipe. The pressure side of the pitot tube was also found to give better results if it did not extend within the pipe but was just flush with the inside.

With this arrangement very accurate results were obtained. At one time, with velocities ranging from 500 to 5,000 ft. per minute and in pipes from ¾ to 2 in. in diameter, an average of 50 obserations showed, when the velocity was calculated by the formula $V = \sqrt{2gh}$, an average error of less than one-half of 1 per cent. and a maximum error in a single observation of less than 2 per cent.

As explained, this arrangement was first used with an ordinary U-tube but as this can give instantaneous readings only, and in many cases the flow to be measured was very irregular, a recording differential-pressure gage was substituted. By this means records could be kept of the flow of air to any department over any length of time. Line leakages were also quickly detected by means of this record.

For pipes of 1¼ in. diameter and larger, the brass velocity tube was screwed directly into the wall of the pipe, but for smaller sizes standard tees were used, the upper branch being plugged and the plug tapped to admit the pressure and velocity tubes. The tee was then filled with lead and drilled to correspond with the diameter of the pipe with which it was to be used.

In applying this arrangement to an air line, two conditions must be met in the connections leading to the U-tube: First, all connections must be perfectly tight. Any leakage, particularly on the velocity side, due to the small opening, will introduce a large error. Every joint should be carefully tested with a soap solution for leakage and if a bubble is observed the joint should be made tighter. The second condition is to have the connections come from the top of the air pipe or, if from the side, have them pitched up at first so as to drain any entrapped water back into the air pipe. If these two conditions are observed, the U-tube or differential-pressure gage may be placed at some distance from the tube connections.

WELDING HIGH PRESSURE PIPE LINES

[The following we condense from a paper read before the Pacific Coast Gas Association at San Diego, September 1912, by Leon B. Jones, Assistant Engineer, Gas Department, Pacific Gas and Electric Company, San Francisco. It gives a clear and interesting account of the welding of line piping for high pressure gas transmission, and as the pipe after the welding was tested, as stated, at a pressure of 150 lb., the welding operation is, of course, equally applicable to compressed air pipes.]

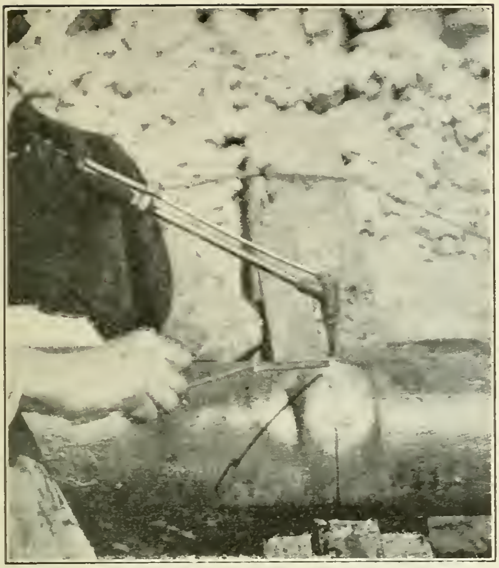
Heretofore the couplings or joints have been the short-lived part of high-pressure pipe lines. In practically all the couplings now in use, a compressible elastic gasket is necessary. Rubber has been used in joints of most of the pipe lines in California, but as the short time in which rubber loses its elasticity is greatly decreased by the rotting effect of the compression liquids of the gas, the life of rubber gasket joints is very much less than the life of the pipe. Pipe lines have been abandoned or removed, because the elasticity of the rubber in the joints was gone, and every coupling was a leak, and still the pipe, if undisturbed, would have had a considerable life. In some cases the gaskets were removed after several years, and the pipe was still in good condition. Up to the present time the life of high-pressure pipe lines laid in the average soil has been the life of the joint. With the recent developments in oxy-acetylene welding, a new era has been reached in the transmission of gas under high pressure. It is now possible to lay a pipe line without couplings of any sort, a steel-to-steel tube in which the joining of the lengths is of the same material as the pipe.

Welding with the oxy-acetylene torch has been successfully done in the large shops for several years, but the recent installation of an 8-in. high-pressure line in San Francisco is unique in the adoption of this process to the welding of high-pressure gas mains. The oxy-acetylene torch develops a flame temperature which may conservatively be estimated at 6,000 deg. Fahr., and it may readily be seen that with this temperature concentrated in a small pencil flame, under perfect control, that all the metals become amenable to the will of the operator. The welding of iron, steel, copper or brass is accomplished with greater ease and rapidity than the soldering of tin. When this powerful little flame impinges on steel, the metal becomes molten in a few seconds.

The recent installation of approximately 5,000 ft. of 8-in. steel tubing in San Francisco, in which the oxy-acetylene welding was used on every joint, was laid under the most difficult conditions, and afforded an excellent opportunity for practically testing the adaptability of welding to high-pressure gas mains. This line was laid in Geary street at the same time the municipal railroad was under construction, and this, necessarily, caused many obstructions and difficulties, but in every case the oxy-acetylene welding proved itself equal to the occasion, and all difficulties were surmounted.

There are three separate methods in which pipe may be handled when welding with the oxy-acetylene torch. Bell holes may be dug as for any coupling, and the pipe welded in the ditch, or the pipe may be lowered into the ditch and turned while the welds are being made; thus the welding of many of the joints is done on the top of the pipe, and the necessity for digging large bell holes at every joint is avoided.

The third method, which was found to be the most practicable, where conditions will allow, is to put short pieces of timber across the top of the ditch at intervals and roll the



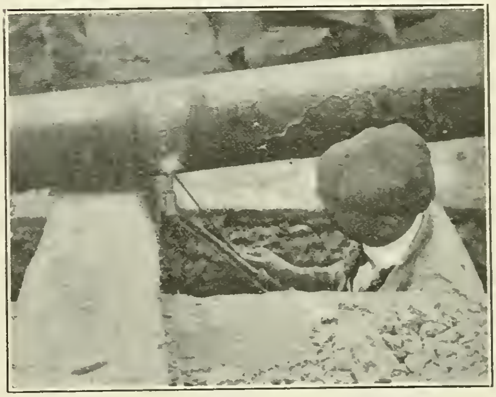
BEGINNING WELD ON TOP OF PIPE.

pipe into places directly over the ditch. This method insures a good alignment of the joint, and requires the least labor. With this method two men can turn as much as 500 ft. of pipe, while the operator is welding the joints, and as 500 ft. is about as long as can be conveniently handled, it will thus only require a bell hole and a weld in the ditch every 500 ft. While it is possible to make a good weld without turning the pipe, a great deal more time and care are necessary than when the pipe is turned, and the welding is always done on the top of the joint. In welding the under side of a joint in the ditch it is not possible to pile up the metal, as when welding is done on top of the joint. A joint being welded in the ditch is also more often allowed to cool before the weld is completed, and this leaves a possibility of pin holes where the weld is commenced again.

To insure against the possibility of the weld not extending through the entire thickness of the pipe, the ends of the lengths to be welded were left about ⅛ in. apart, and the operator worked with a rod of $^3/_{16}$ in. Norway iron in his left hand. This iron is melted into the joint to take care of the gap, and also to build up the metal around the joint. In this way the ends of the pipe are perfectly welded, and the metal at the joint is thicker than in the pipe, thus making the joint the strongest part of the line. To prove this statement that the weld is as strong, if not stronger, than the rest of the pipe, sample welds were made, and the pipe was afterwards flattened and bent until it was broken. In every case the break occurred back of the weld in the pipe and not across the joint.

A more practical test, which will appeal to gas men, was also made as follows: Two 40-ft. lengths were supported on timbers laid across the ditch, and the ends welded together. All the supports were then removed from under one of the lengths, and the entire weight of this 40-ft. length was suspended on the joint. The weld was in no way affected by this severe treatment. After several hundred feet of pipe are welded into a section, the supports are removed one at a time, and the pipe is reeled into the ditch like so much cable. Careful handling is no longer necessary, as a weld, if properly made, will stand the same treatment as the pipe, and any defect is better detected before the pipe is covered.

It may be readily seen that when welding the pipe on top of the ditch into sections several hundred feet long it is possible to work several welding outfits at the same time, with the minimum of labor. If a little care is exercised in distributing the pipe along the ditch, two men can readily roll it into place, over the ditch, for welding. In many cases, after these sections were reeled into the ditch, the ends of the sections were several feet apart. To avoid using a short piece of pipe and making two welds, a block and tackle was used, and with an automobile for a motive



WELDING ON UNDER SIDE OF PIPE.

power, these sections, in some cases 500 ft. long, were dragged several feet in the ditch to meet the end of the next section.

As the tubing which was used on this line was approximately $^3/_{16}$ of an inch thick and would not permit of threading, the question arose as to how valves or governors should be connected. This was solved in a very simple manner. A short piece of 8-in. standard pipe was threaded onto a standard flange. The standard pipe, which was 8 in. inside diameter, was then slipped over the tubing, which was 8 in. outside diameter. After the valve or governor was installed, and the flanges bolted up, the end of the standard pipe was welded to the tubing.

THE PRESSURE TEST.

This installation, which represented about 180 joints, was welded throughout its entire length. At the end of each day's work the line was tested to 150 lb. pressure and allowed to stand over night. As an extra precaution the joints were also gone over with soapsuds. After completion the entire line was tested to 150 lb. pressure. The line stood at this pressure for three days without loss.

There are two general methods in which calcium carbide and water may be brought together for the purpose of generating acetylene gas—"water to carbide," or "carbide to water." Generators may, therefore, be classed as water feed or carbolic feed. In the early stages of the development of acetylene, most of the generators were of the water to carbide, or water-feed type. This was due to the fact that it was far easier to regulate the flow of liquids than of solids. However, practice has proven the carbide feed type to be the safest and also to produce the purest acetylene. In this type the carbide is fed into an excess of water, and therefore the temperature of the generators cannot exceed the boiling point of water, and the acetylene, in bubbling up through the lime water formed in the generator, is freed from most of its impurities. The heat produced from 1 lb. of calcium carbide and the slackening of the calcium oxide formed is sufficient to raise 4 lbs. of water from the freezing point to the boiling point. It is, therefore, essential that the water in an acetylene generator shall always be in excess. If a few general precautions are taken there need be no danger in the production of acetylene.

But the compression of acetylene is another story. One of the dreams of the early acetylene industry was that this gas might be safely compressed into a liquid form for convenient transportation and storage. This would appear to be an ideal condition, as acetylene liquefies at the comparatively low pressure of 700 lb. per square inch, and a cubic foot of liquid acetylene represents 400 cu. ft. of gas. This liquid is only four-tenths as heavy as water. It must be remembered that acetylene gas is an endothermic compound. In its formation heat is absorbed, and that spontaneous decomposition will take place, liberating this heat if subjected to abnormal temperature or pressure. Many violent explosions have occurred due to liquefied acetylene, and now acetylene compressed in open containers to a pressure exceeding two atmospheres (30 lb.) is considered a very dangerous material. However, calcium carbide represents a more condensed form of acetylene for transportation than the liquefied gas. A cubic foot of carbide represents about 500 cu. ft. of available gas, while a cubic foot of liquefied acetylene represents only 400 cu. ft. of gas.

Recent developments have also provided a substitute for liquid acetylene in what is known as dissolved acetylene. While acetylene is soluble in its own volume of water, its very great solubility in acetone has broadened the field of the uses of acetylene many fold. Acetone will dissolve 24 times its volume of acetylene at atmospheric pressure, and for each additional atmosphere to which it is subjected, a similar quantity will be dissolved; in other words, the solubility increases directly with the increase in pressure. Dissolved acetylene makes possible hundreds of uses of acetylene and the oxy-acetylene blow pipe, which would have been impossible before its discovery.

With the use of dissolved acetylene and oxygen under pressure, a complete oxy-acetylene welding outfit is very readily portable and ready for instant use and can be used in many places where a generator would be impracticable or impossible. When acetylene is dissolved in acetone it seems to be devoid of all possibility of an endothermic explosion under pressure. But the bulk of acetone is greatly expanded by this great absorption of acetylene, and it will readily be seen that any container used for acetone for the dissolving of acetylene must be in capacity equal to the acetone expanded.

As the acetylene was used from such a container and the acetone contracted to its normal bulk, other spaces would be left above the liquid in which free or undissolved acetylene would exist, and thus create danger from explosion. This is overcome by the use of a porous solid which is inert to the acetone and also to the acetylene. Asbestos is adaptable for this purpose, and as it is from 75 to 80 per cent. porous the tanks can be packed to exclude all possibility of open spaces for free or undissolved acetylene, and yet leave the greater part of its capacity for acetone and dissolved acetylene. Calcium carbide can now be obtained at 5 cents per pound, and as a pound of carbide will produce 5 cu. ft. of acetylene, the cost of acetylene will be 1 cent per cubic foot at the generator; with an additional cost for compression if it is desired to use dissolved acetylene from tanks under pressure.

PRODUCTION OF OXYGEN.

Until the introduction of the autogenous or oxy-acetylene welding practically all of the oxygen used in the United States was used for medical purposes and consequently exorbitant prices were obtainable. But since the entrance of oxygen into the commercial field many fertile minds have been busy with the problem of its economical production. Probably the most widely known method is from the reaction of certain chemicals. Oxygen is easily obtained by heating chlorate of potash or chlorate of soda, but as the reactions take place violently, with the resultant release of all the oxygen at once, the reaction is impeded by the addition of one-quarter part of dioxide of manganese. With the addition of the manganese dioxide, the oxygen is given off continuously until the reaction is complete. Another method is the use of chloride of lime and copper sulphate, with the addition of iron sulphate as a catalyzer. But as the use of chemicals for the production of oxygen is not feasible on a large scale and the economy limited by the price of the chemicals, other methods must be resorted to.

Oxygen may be very cheaply produced by the liquefication and distillation of air. The air is liquefied by high pressure and low temperature, and the oxygen and nitrogen separated by distillation due to their difference in boiling points. This is probably the most economical method of producing oxygen, as there is an unlimited market for the residual nitrogen as a fertilizer. This method requires an extensive and expensive outlay for equipment, and the market for oxygen has not, as yet, warranted the installation of such a plant in the United States, although oxygen has been produced in large quantities in this way in Europe for several years.

Acetylene gas of all the hydro-carbon gases most nearly approaches pure carbon. It is over 92 per cent. carbon and has a heat value of 1,685 B. t. u. per cubic foot, and this partly explains the remarkable temperature attained with the oxy-acetylene blow pipe. Acetylene requires for complete combustion 12½ times its volume of air, or 2½ times its volume of pure oxygen. If complete combustion were attained by burning acetylene with 2½ times its volume of oxygen the products of combustion would be carbonic acid and water.

However, it has been practically proven that the best welding results are obtained by the use of slightly over one and one-quarter volume of oxygen to one volume of acetylene, and with this incomplete combustion the products of the combustion change, carbon monoxide and hydrogen being formed instead of carbonic acid and water. To this formation of hydrogen, which surrounds and envelopes the point of welding, is attributed the fact that the oxy-acetylene has no injurious effect upon the metal.

The actual cost of the oxygen for the oxy-acetylene torch is materially less than would be calculated. The torch is constructed upon the injector principle in which the oxygen and acetylene are conveyed through separate tubes to within an inch of the point of combustion. The acetylene is usually conveyed direct from the generator through hose connections to the torch at a pressure of 3 to 5 lbs. The oxygen is stored in tanks and is used through a reducing valve and hose connections to the torch at between 15 and 20 lb. On the handle of the torch are controlling valves for nice regulation. The acetylene is first turned on full and lighted and then oxygen is added until the flame becomes a single cone. An excess of acetylene produces two cones and a white color, while an excess of oxygen produces a violet tint.

The hourly consumption of the torch used for 8-in. steel pipe was 24 cu. ft. of acetylene and 30 cu. ft. of oxygen. Using acetylene direct from the generator at a cost of 1 cent per cu. ft. and oxygen from tanks at 6 cents per cu. ft., the cost of operating would be $2.04 per hour, and allowing 40 cents per hour for the operator, the total cost would be $2.44 per hour. As the average time necessary to weld a joint on top of the ditch, where the welding is done on the top of the pipe, is 10 minutes, the cost of such welds would be slightly over 40 cents per joint. The time necessary to weld a joint in the ditch, where the operator was forced to weld underneath the pipe, was 28 minutes per joint, making the cost of these joints $1.13 per joint. If the pipe is welded in long sections on the ground it is only necessary to have a weld in the ditch to every ten joints welded on the ground. This would make an average cost of 49 cents per joint. This would be approximately 2 cents per inch of circumference on steel pipe $^3/_{16}$ in. thick, and from this can be estimated the cost of welding different sizes and thicknesses, as the time per weld and consumption of oxygen and acetylene will be in proportion to the size and weight of the pipe.

OUR WASTE OF COAL TAR PRODUCTS

Over a million tons of coal tar was recovered last year in Germany as a by-product of the coke and gas industries. This was an increase of over 100 per cent. in ten years, and represented a selling value of about ten million dollars. In Germany 90 per cent. of industrial works of this kind are now made to yield such products, as against something less than 20 per cent. in this country. In all others the coal tar is thrown away.

Foremost among these coal-tar products are benzol, tuluol, xylol, solvent-naphtha, ammonia, and the cyanides; next come pitch, anthracene, pyridia, naphthalene, the light, medium and heavy oils, and in further development etheric oils, perfumes, drugs and dyes. The work involved gives employment to an army of people of every grade, from the highly trained scientific expert and investigator, through the ranks of merchants, clerks and skilled mechanics to day laborers. We read:

Of surpassing importance is the recovery of ammonia from the gases in the form of the sulphate and of sal ammoniac. To-day Germany controls the world-market with an output of more than 410,000 tons of the ammoniac salts, having a selling value of over $25,000,000. Besides many chemical applications—as in the manufacture of explosives—ammonium is especially employed as a fertilizer.

Benzol is the mother substance of a large number of important aromatic compounds and of artificial dye-stuffs, besides its use as a solvent and purifier for numerous organic bodies, such as caoutchouc and gums.

Purified tuluol yields many dyes, and is used in making explosives, medicinal preparations, perfumes, and so forth. Cyanide has long been used in gold-washing, and is at present used in making "Berlin blue." These manifold constituents of coal tar are separated by means of the process known as fractional distillation, based on the fact that the various components possess specific boiling-points.

FORMULAS FOR FLOW OF GAS

In a paper read before the Illinois Gas Association, Chicago, Mar. 21, 1912, Mr. J. M. Spitzglass gave the derivation of formulas for determining the flow of high- and low-pressure gas, based on modifications of Unwin's formulas, the constants being obtained from experimental data furnished by the engineering department of the People's Gas Light & Coke Co., of Chicago. These formulas are as follows:

For high-pressure gas,

$$Q=64.3\surd(PAD^5\div WLK);$$

For low-pressure gas,

$$Q=1910\surd(HD^5\div WLK),$$ in which Q=discharge of free gas, cu. ft. per hour; P=drop of pressure due to pipe friction, lb. per sq. in.; A=average absolute pressure, lb. per sq. in.= (initial pressure+final pressure) ÷2; D=pipe diameter, in.; L=length of pipe, miles; W=specific gravity of gas (air=1); H=drop of pressure, in inches of water; $K = 1+(3.6\div D)+0.03D$.

EFFICIENCY OF GAS COMPRESSORS

By P. F. Walker, Prof. Mechanical Engineering University of Kansas.*

Efficiency has many definitions and meanings. My theme in its entirety contemplates the type of gas compressor used so generally throughout the mid-continental field, consisting of the compressor itself and its driving engine of the internal combustion variety, and to it we may apply efficiency conceptions to the number of seven—perhaps more.

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*Annual Meeting, 1912, Natural Gas Association.

1. Volumetric efficiency, based as usual on the total actual volume of piston displacement filled to the full with gas of the pressure and temperature found in the intake line outside the inlet valves.

2. Mechanical efficiency of the compressor alone, perhaps better styled cylinder efficiency, relating to the work actually expended upon the gas to that required by a theoretical compression cycle with a suction line at full intake pressure, discharge line at even discharge—line, pressure, compression curve a perfect isothermal, and with no clearance. It fails of perfection by reason of clearance irregularities, loss in the valves, and fluid friction or head to produce flow into and out of the cylinder. It may be best expressed by a factor greater than unity, based on the theoretical power required.

3. Mechanical efficiency of the unit, or the ratio of the indicated powers in the compressor and power cylinders.

4. Thermal efficiency of the driving engine, based on the heat value of the fuel consumed.

5. Thermal efficiency of driving engine, based on the ideally perfect engine cycle under the existing conditions of fuel treatment.

6. Commercial efficiency of the unit, or economy, based on the handling of a stated amount of gas, fuel costs only considered.

7. Same as number 6, but including costs of attendance, upkeep and depreciation, etc.

This paper will emphasize the first two in the main, but will consider all excepting the last in more brief statement.

VOLUMETRIC EFFICIENCY.

This is a factor in continual use by compressor men and its determination is of great importance. A method of doing this has been followed in recent work by the writer, which may be of some interest and will be given here.

The indicator is the only source from which such information may he gained, and the handling of the card is the principal point of the work. From it the volume changes of gas actually within the limits of piston travel may be found by direct measurement. In order to combine volumes with pressures in equations based on the gas laws the absolute volumes must be known, however, calling for the cylinder clearance volume, and in order to compare any two volumes of gas the temperatures must be known as well as the pressures. Volumetric efficiency being based upon the full displacement volume of intake gas at its existing pressure and temperature, it is clear that the temperature at points on the card must be determined first. The first step in this process is to find the clearance volume.

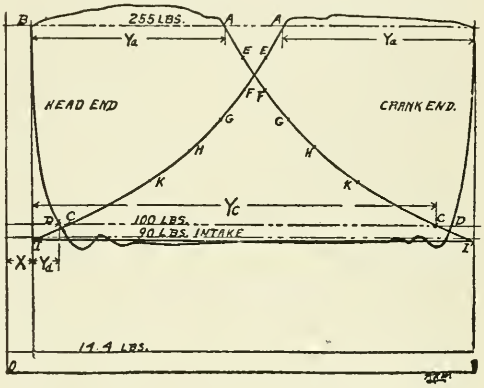


FIG. 1.

Referring to Fig. 1, a typical card is shown with two horizontal lines drawn across, one cutting the compression and re-expansion lines at points A and B, and the other at points C and D. The clearance volume is represented by the unknown distance X, while volumes of change, measured to the several points from the end of the card, are represented by the symbols Ya, Yb, Yc, Yd. The upper reference line, A and B, is usually taken at the discharge pressure as gauged in the main, for which position the valve of Yb will always be zero. The lower line C—D is located preferably at a few pounds above intake pressure, since the card often has certain irregularities at the latter level and it is essential that the points be on the true regular curves. The figure shows both head-end and crank-end cards, but the head-end one only is fully dimentioned. In taking measurements both cards have been scaled and the averages used in the calculations, in some of the work the averages from several separate cards being used directly. The points E, F, G, H and K, duplicated on both cards, are points at pressure levels 24 lbs. apart, at which points volumes are measured for subsequent work.

The equation of the compression curve, which will enter largely into the following work, may be taken in the form usual for all such calculations, namely:

$$P V^n = \text{Constant.}$$

For the purposes in view we may assume that the compression and re-expansion curves both have the same value for the exponent 'n' in this equation, hence for the curve between points A and C on the one, and between points B and D on the other, we write the equations

$$P_a V_a^n = P_c V_c^n$$

$$P_b V_b^n = P_d V_d^n$$

Dividing the first equation by the second, remembering that P_a and P_b are equal and that P_c and P_d are equal, we have

$$\frac{V_a^n}{V_b^n} = \frac{V_c^n}{V_d^n}, \text{ or } \frac{V_a}{V_b} = \frac{V_c}{V_d}$$

Now the true volume at A, designated as V_a equals the dimension Y_a scaled from the card, plus the unknown clearance X. Similarly with the other volume.

Substituting these values, we have

$$\frac{Y_a + X}{Y_b + X} = \frac{Y_c + X}{Y_d + X}$$

Reducing and solving for X we find

$$X = \frac{Y_a Y_d - Y_c Y_b}{Y_c + Y_b - Y_a - Y_d}$$

Returning now to the first quotation

$$P_a V_a^n = P_c V_c^n$$

We may substitute the numerical values found for $(Y_a + X)$ and $(Y_c + X)$ for V_a and V_c.

In order to find the numerical value of 'n' we may write the original equation in the form

$$\frac{P_a}{P_c} = \left(\frac{V_c}{V_a}\right)^n$$

Taking logarithms,

$$\text{Log. } P_a - \text{Log. } P_c = n\,(\text{Log. } V_c - \text{Log. } V_a)$$

$$\text{from which, } n = \frac{\log P_a - \log P_c}{\log V_c - \log V_a}$$

Making the calculations indicated for four sets of cards in the last series which has been handled by the writer, one of which has been copied to make Fig. 1, two sets from one cylinder and two from the other cylinder of a compressor unit, clearance for one cylinder is found to be 5.41 per cent. and for the other 5.83 per cent. of the piston displacement. The average value of the exponent 'n' for the first cylinder is found to be 1.264, and for the second 1.275, the two averaging at 1.2695. In a former extensive series of calculations on about 80 indicator cards taken from sixteen compressors of four different sizes and of two different makes, with clearances ranging from 2.08 per cent. to 4.8 per cent. the average value found for the exponent 'n' was 1.33. The compressor which in this former investigation gave the largest clearance of 4.8 per cent. is the same compressor used in the last investigation when values of 5.41 and 5.83 per cent were found. This particular compressor has been modified since its installation, the piston having been turned off slightly to give more linear clearance inside the heads, thus accounting for the unusually large value.

Some surprise may be occasioned by reason of this exponent having so large a value on the actual card. It is customary to compare the actual curve with the theoretical curve which would be traced were the compression carried on in a cylinder made of non-conducting material, the walls of which could neither impart heat to the gas nor absorb it.

Such a theoretical curve, when the gas is a so-called perfect gas, has an exponent 'n' equal to the ratio of the specific heat at constant pressure to the specific at constant volume. These two specific heats for methane gas have average values over ordinary temperature ranges of 0.655 and 0.539 respectively, giving a ratio of 1.22.

Now in an actual compressor the gas loses heat to the cylinder walls and hence to the jacket water during compression, which tends to give a flatter curve with an exponent smaller than that for the ideal curve in the non-conducting cylinder. In seeking an explanation for the apparent paradox the writer took up the study of the physical laws of methane gas, taking into account the variations from a perfect gas, basing his work on the experiments of the French scientist Amagat. The work was somewhat complex, and is not repeated here, but the main results were as follows:

(a) For constant temperature changes, instead of following Boyles Law, P V = Constant, methane has the form of equation written in the above work with an exponent 'n' varying from .97 to .99 for different pressure variations.

(b) For constant pressure, instead of following Gay Lussac's Law of temperature varying in direct proportion to the volume, it follows an equation of the form

$$T = 138.1\ V + 41$$

the numerical values here used applying to a pressure of 100 lbs. per sq. in.

(c) For the ideal adiabatic curve followed in the non-conducting cylinder the exponent "n" has varying values for the different ranges of pressure, but for the usual conditions of natural gas compressor operations with intake pressure of about 100 lbs., it varies from 1.4 to 1.5 with different discharge pressures. This explains the fact of the cards' showing exponents larger than the specific heat ratio.

With the equation of the compression curves established, the ultimate aim is the determination of the true equivalent volume of gas handled by the compressor during a complete cycle, from which the volumetric efficiency is derived. An active influence in this determination of volume is the temperature of the gas during the compression stroke. No satisfactory direct method of finding this is available, and none may be possible, since it is the average temperature of the whole body of gas in the cylinder that is needed and this may be quite different from that near the metal walls. The following approximation has been carried out.

Temperatures on the compression curve will vary approximately according to the equation

$$\frac{T_a}{T_c} = \left(\frac{P_a}{P_c}\right)^{\frac{n-1}{n}}$$

This is assuming that gas follows the perfect gas law in this respect, and in most calculations this probably involves a smaller error than that incident to measurements from the indicator cards where measured values are used in calculations for absolute values, not for comparative values.

The temperatures of the gas at intake and discharge, in the pipe connections close to the cylinder, were 41 degs. and 185 degs. Fahr., respectively, for the times of taking the four sets of cards which form the basis for the present calculations. 460 degs. are to be added to the absolute temperatures, and the barometer during the test gave the atmospheric pressure as 14.4 lbs. The suction line was, by measurement, about 1.8 lbs. below the intake line of 90 lbs., and this value of 88.2 lbs. will now be used instead of the values at the arbitrarily fixed level of the line C-D of Fig. 1, the corresponding volume being full displacement volume plus clearance, or 5.524 cu. ft. For this point of beginning compression the symbols Pl, Vi, Tl will be used.

The temperature of the gas at the beginning of the compression stroke will be above that at the intake valves, due to the heating influence of the cylinder walls during the suction stroke. The inner surface layer of metal is at its highest temperature at the end of the preceding discharge stroke, and is cooled, of course, as its heat passes to the incoming gas. Similarly the discharge gas is cooled by the action of the metal and water combined during the remainder of the stroke following the opening of the discharge valves, so that the highest gas temperature exists at the end of the compresion curve proper, at point A on Fig. I. How much these two temperatures at the beginning and end compression are above the observed temperatures outside the valves is the question to be determined.

As a first step it is assumed that the temperature at "A," Fig. 1, is the same as that in the discharge line. Solving the last equation noted above, with Ta = 64 degs. absolute, Pa = 269 lbs., Pl = 101.6, and with the average value of n = 1.2694, we find Tl = 525 degs. abs., which is 24 degs. above the temperature observed in the intake line. That is, under such conditions, the intake gas was heated 24 degs. during suction. This result indicates that the heating of the gas during suction will remain greater in number of degrees than the cooling during discharge by an amount somewhat less than 24 degs., as different values of temperature are assigned to point A. The problem before us then is to determine how much allowance in temperature is suitable for the cooling effects of the walls during the discharge period.

Studying the conditions affecting the heat transfer it will be apparent that the three most significant factors are:

(a) The period of time occupied by the process.

(b) The area of contact surface.

(c) The difference between gas and metal surfaces.

Since the valve head, which forms the real cylinder head in contact with the gas during discharge, or not water cooled, the most effective cooling surface is the cylindrical wall, so that the areas of contact are approximately proportional to the length of stroke traversed, as is also the time. That is the discharge being for nearly half a stroke, the time of a half stroke being nearly in proportion to the time for a full stroke, this relationship may be taken.

For the four sets of cards under consideration in the average length of stroke traversed after discharge begins is 1.926 in. on a card length of 4.38 in., or 44 per cent. of the stroke. From these two considerations, then, we would expect the drop in temperature during discharge to be 44 per cent. of the rise during suction, or 45 per cent. will be used since the cylinder head effects are relatively greater for the shorter stroke.

As to the third factor much greater difficulty is encountered in determining relative values, but it is believed that the following calculations throw light on the question:

The value of the exponent 'n' on the compression curve indicates whether heat is being added to or taken from the gas. On the compression curve an exponent less than that representing the adiabatic curve means that heat is being transmitted to the cylinder walls, and a larger value means that heat is passing from the walls to the gas. To test this matter, measurements were taken from the eight indicator cards at points designated as E, F, G, H and K, Fig. 1, the pressures and volumes averaged, and the value of the exponent calculated for each interval between points according to the method described for the larger portion A-C, with the following results:

Beginning at the point '1', beginning of compression, we find:

For portion 1—C, n = 1.415
For portion C—K, n = 1.242
For portion K—H, n = 1.316
For portion H—G, n = 1.287
For portion G—F, n = 1.273
For portion F—E, n = 1.270
For portion E—A, n = 1.250

The first value indicates that from 1 to C the curve is essentially an adiabatic, neither receiving nor losing heat on the average. Undoubtedly the gas receives some heat during the first portion of the distance and loses some during the latter. During the period the temperature rises about 27 degs., so that it is evident that the walls are down to approximately 20 degs. of the gas.

The last value, for the portion E-A of the curve, indicates that the temperature rose 60 per cent. of the amount that it would have risen on an adiabatic between the same pressures, or that heat was being withdrawn at the rate of 40 to 50 per cent. of the amount necessary to hold a constant temperature. This is equivalent to cooling the gas 4 degs. during the time involved, which means a rapid heating of the metal surface. No data is available to show what difference in temperature is necessary for the flow of this amount of heat, but the difference will diminish rapidly as the one substance rises and the other falls, and it does not seem unreasonable to expect that it will become not more than 20 degs. at the end of discharge—the same difference as at the end of suction. It is understood that these conditions apply to but a thin film of metal on the surface, the fluctuation growing less and approaching zero at a moderate depth.

Both periods of suction and discharge are thus seen to be under similar conditions. At the beginning of each the temperature difference is considerable but diminishes toward the end, and it is not unreasonable to assume that the mean difference is approximately the same for both. This means that the heat transfer conditions indicate that the cooling during discharge is 45 per cent. of the heating during suction, and it has been shown that the difference between the two values will be somewhat less than 24 deg. We may therefore solve as follows:

(Temp. fall on Disch.) = .45 × (Temp. rise on Suct.)

(Temp. rise on Suct., — (Temp. fall on Disch.) = 23.5 deg., approx.

Then (Temp. fall on Disch.) = 19.25 or say 20 deg.

Temperature at point A may then be taken as 205 deg., or 665 absolute. The resulting temperature at beginning compression is then found to be 542 deg. absolute, or 82 deg. Fahr., and at the point C, 569 deg. abs. or 109 deg. Fahr. Having probable temperatures at points A and C, we may now compute the volumetric efficiency by first finding the equivalent volume at 90 lbs. gage pressure and 41 deg. Fahr.

Equiv. Vol. (from point A) $= 2.296 \times \frac{269}{104.4} \times \frac{501}{665} = 4.45$ cu. ft.

Equiv. Vol. (from point C) $= 4.514 \times \frac{114.4}{104.4} \times \frac{501}{569} = 4.37$ cu. ft.

Mean equivalent volume = 4.41 cu. ft.

Vol. Eff. $= \frac{4.41}{5.23} = .844$ or 84.4 per cent.

It is interesting to note that without the temperature correction the volumetric efficiency would have been found to be 87 per cent.

Referring again in pasing to the varying values of 'n' along the compression curve, the occurence of the low value, 1.242, on the portion C-K is somewhat paradoxical. It indicates rapid flow of heat to the walls. One explanation may be that saturated vapors below the temperature of 139 deg. at point K would make more rapid the flow of heat to the walls, which would change as the vapors became superheated.

MECHANICAL OR CYLINDER EFFICIENCY.

While mechanical efficiency is usually understood to be the ratio between indicated horsepower and the actual brake horsepower at the engine shaft of applied horsepower at the compressor shaft, it is the thought here to include under the term the losses in the cylinder, as follows:

(a) Loss due to clearance.

(b) Friction in cylinder and valve passages, restricted flow of gas.

(c) Pressure necessary to open and hold open the valves.

(d) Excess of work actually done over that necessary for compression under constant temperature conditions. Since the compressed gas entering the transmission line quickly resumes the temperature of the earth, no advantage results from increased temperature.

(e) Power necessary to circulate cooling water, which should be charged against the cylinder. Approximate calculation only is possible. Should be added to indicated horsepower of compressor rather than to the work of driving the piston, since it is not a loss of power in the driving mechanism but stands in place of an increased card area which would result from the higher temperature in an uncooled cylinder.

No attempt will be made now to separate these individual items, excepting that the last is separate from necessity.

The standard indicator card is that with a true suction line at 90 lbs. pressure; isothermal compression to 225 lbs.; discharge along a true constant pressure line of 255 lbs.; constant volume drop, without clearance gas, to the intake pressure. The volume of gas drawn in during suction, which will be the total absolute volume, will be the true amount of gas handled in one cycle, and equal to piston displacement volume times volumetric efficiency of the actual cylinder. This is 5.23 / .844 = 4.414 cu. ft. The gas will be treated as a perfect gas, since for this range of pressure the equation for isothermal compression of methane would have an exponent 'n' equal to .98, against a value of 1.0 for a perfect gas, and the error involved is less than that in the card data.

The following calculation holds:

Vol. at end of compression $= \frac{104.4 \times 4.414}{269.4}$

= 1.713 cu. ft.

Work area = 144 (269.4 × 713 (1 + loge
269.4

$$\frac{}{104.4}) - 104.4 \times 4.414) = 63{,}040 \text{ ft. lbs.}$$

Horsepower at 86.8 rev. per min.

$$= \frac{63{,}040 \times 2 \times 86.8 \times 2}{33{,}000} = 764$$

Work required to circulate the water is approximated as follows:

Water used in test for two cylinders = 310 lbs. per min.

Assume necessary head to be 40 ft., and efficiency of pumps as 50 per cent.

$$\text{Then h. p. required} = \frac{310 \times 40}{33{,}000 \times 50} = 0.75$$

Total i. h. p. from actual cards = 919.5.

and with water h. p. added = 920.25.

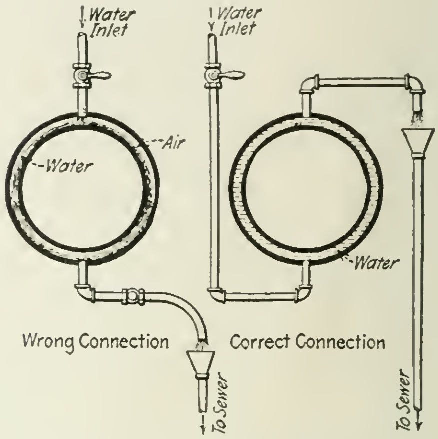
Ratio, actual work to theoretical work =

$$\frac{920.25}{764} = 1.20.$$

Losses aggregates 20 per cent. of theoretical power, or 17 per cent. of actual power.

This conception of efficiency has a direct significance when the compression of gas is treated as a means of producing line flow. The purpose of compression may be taken to be the production of line flow conditions, which involves the expenditure of energy to overcome resistance. The gas when discharged at the higher pressure into the mains is enabled, by virtue of the increased pressure, to supply the necessary energy, but it does so by drawing that energy from the ground in which the pipe line is buried and applying it, not by the expenditure of any internal energy imparted to it during compression.

The situation is as follows: The gas may come from the compressor at an increased temperature, but before it has applied any appreciable amount of energy in the producing of flow it drops to the temperature which it formerly had by radiation of heat to the earth or atmosphere. All that the compressor has done is to raise the pressure, the cylinder having received as much energy during the suction stroke as it expends in forcing the gas back into the mains after the discharge pressure has been attained, excepting in so far as losses above discussed change conditions. If the compressor adds heat to gas as well as pressure the heat is promptly dissipated and it stands as a compressor loss. The gas then proceeds to expand isothermally, drawing an amount of heat from the ground exactly equal to the energy imparted to the gas ahead, a process just the reverse of the compression process treated as the ideal. The efficiency value just found is, then, a direct measure of compression as a means of producing flow.

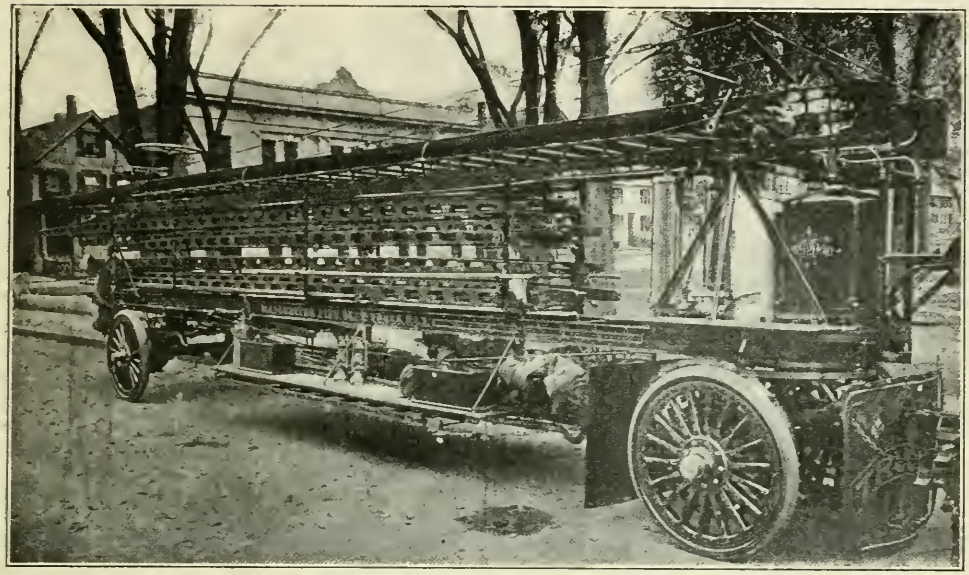


WATER JACKET CIRCULATION

The following little story is told by a contributor to *Power*. He says:

"Soon after arriving in this country, I secured a position as general mechanic with a Canadian railroad. I could not speak English very well so experienced trouble in connection with my work. On one occasion I was sent to look at an air-compressor cylinder which was always running hot. The foreman was very upset over the case as a man had been working on it for three days and left the job with the cylinder in the condition he found it. The water connections were wrong, and after a half hour's work I changed them and the trouble ceased. I had considerable difficulty in explaining how the job was done, so I drew the sketch shown so that he could understand what I tried to explain. He was so pleased he told me to take the rest of the week off and go fishing."

The sketch shows up the matter very clearly and completely. With the first arrangement the jacket was not kept full of water, while after the pipes were changed it was necessarily entirely filled and all the surfaces were kept cool. The quantity of water required would not be as great as suggested by the overflow in the sketches. Only a very gentle flow is needed and then the water does not get very warm, but still it is indispensable.



PNEUMATIC ELEVATING TRUCK.

LADDER TRUCK WITH PNEUMATIC ELEVATOR

The halftone here reproduced from the *Municipal Journal* shows a unique ladder truck in service at Manchester, N. H. The principal feature of the truck is an 85 foot extension ladder which in the original construction was raised by a screw-hoist which took considerable time to operate. A pneumatic hoist is now employed and the ladder can be swung to position in ten or twelve seconds. The application of the pneumatic device favored other improvements. The main ladder was formerly 36 inches lower and the other ladders were carried on top of it and had to be removed before it could be raised. This truck now carries, without interferring with the extension ladder, 10, 14, 16, 23, 25, 30, 35 and 50 foot ladders, two scaling ladders, one a 16 and the other a 14-footer, plaster hooks of various kinds, door openers, pitch forks, brooms, all kinds of rakes and other appliances. The truck is 65 feet long from the end of the poles to the end of the extension ladder, is 26 feet between wheel hubs and weighs, with driver and tillerman, about 11.000 pounds.

The hoist is carried upon the forward section and consists of two tanks and two lift cylinders and plungers. Air is compressed at the station by means of an ordinary motor-driven compressor, and at every filling the gauge on the larger and most forward tank is made to stand at 350 pounds. The second tank is filled with a special oil, called "zero oil" by the makers because of non-freezing properties. The presence of alcohol in the mixture can be detected from the odor of the exhaust after the ladder is raised. Air is admitted from the main tank into the secondary tank by means of proper valves, and it is usually found necessary to raise the pressure to about 225 pounds in lifting the ladder. The hoisting plungers work in heavy brass cylinders, pivoted at the base so as to follow the line of the ladder. An automatic valve is attached so that when the ladder reaches an angle of 45 degrees no further pressure can be transmitted to the liquid in the plunger cylinders. If desired, then it can be raised higher by opening a by-pass valve. With one filling of the main tank eight lifts to full height can be made and a correspondingly larger number of short lifts.

Springs may be plated with nickel, but frequently will break when brass or copper plated. This is caused by the penetration of the hydrogen gas, given off during the plating, into the steel. It renders them brittle.

A SELF CONTAINED DIVING OUTFIT

The diving outfit designed by Messrs. Drägerwerk of Lubeck, Germany, makes the diver independent of atmospheric air, by supplying him with oxygen and regenerating the air he expires. The outfit comprises an apparatus worn like a knapsack where the air circulating in the helmet and the diving suit is purified automatically of the deleterious gases produced by breathing and regenerated by an addition of oxygen. The diver thus has at his disposal 60 to 70 liters of air per minute, i. e., 3,600 to 4,200 liters per hour, which suffices for even the most exacting work.

The regenerating apparatus comprises steel cylinders filled with compressed oxygen, a potash cartridge and circulating arrangement, viz., a suction and pressure nozzle and a pressure reduction valve. It is connected with the helmet by two short lengths of hose, one of which serves to draw off any used-up air, while the other supplies fresh air.

The apparatus is started up by opening a valve which is very easily handled; it will work from 2 to 3 hours, in accordance with the personal skill of the diver and with the quantity of carbonic acid secreted by his lungs.

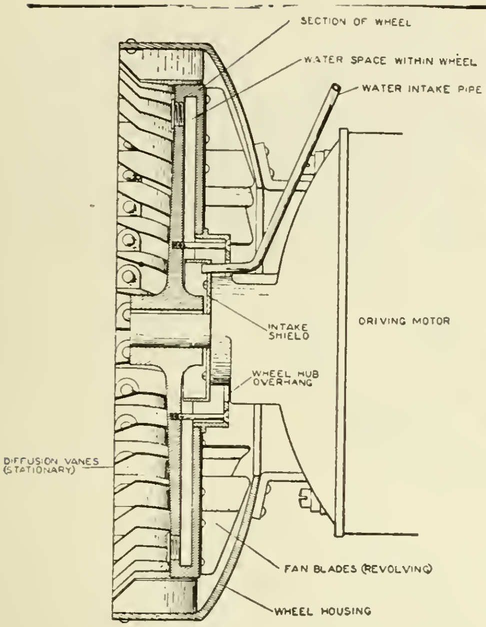
In the place of the usual lead ballast, the diver carries on his chest a weight constituted by steel bottles where compressed air or highly compressed oxygen is accumulated. Whenever the diver wishes to reach the surface without any outside help, he simply opens the valve of these bottles, thus causing air to flow into his outfit and to impart to the latter the required buoyancy. This is how in cases of emergency he will from any normal depth reach, in a few moments, the surface of the water. A safety valve actuated with any excess pressure prevents the diving outfit from bursting with any accidental rise from considerable depths. If on the other hand the diver happened to fall even to a small depth, his life would be seriously endangered unless some special safety device were provided. In fact, any sudden increase in pressure would throw the diver's body into the helmet, like the piston of an engine, while the congestion produced at the same time might cause the man to swoon, so as to be unable to prevent a catastrophe. In order to obviate this danger, the helmet of the new diving outfit has been made of a subtle and substantial India rubber fabric, protected by a metal cover against any mechanical injury. Should the diver happen to fall, the pressure of the water would compress not only the air in the outfit, but the air in the helmet, the India rubber fabric of which will yield in the same way as that of the outfit. While the diver thus would feel the sudden increase in pressure, he would experience it uniformly on all sides, which would first of all prevent congestion. He will thus be able, with full consciousness, to allow some air to enter his outfit from the ballast on his chest, thus re-establishing normal conditions at a moment's notice. A safety acting telephone, which on account of the feeble noise of the air circulating in the apparatus insures a very satisfactory connection, can be attached to the helmet. The telephone cable and signalling string can be combined in a safety cable for hauling the diver to the surface in cases of emergency.

The type of apparatus so far designed is destined for depths of 20 meters as a maximum. Apparatus allowing the diver to work at greater depths are in course of preparation.

The carbonic acid expired by the diver is absorbed in the potash cartridge attached to the knapsack apparatus where the air passes in succession some flat cups lined with numerous grains of potash and soda which absorb any trace of carbonic acid. The air thus freed from any deleterious gases produced by breathing reaches the suction and pressure valve, in order there to be regenerated with a supply of 2 liters of oxygen per minute. The air conduit supplying the fresh air to the mouth and nose of the diver, closes the cycle performed by air circulation. The diving outfit acts, both as a breathing bag and an air reservoir in critical moments.

A special feature of this apparatus is its allowing the diver to work for hours below the surface without any connection with the land or ship, whenever the safety string has been cut or the telephone connection interrupted. Any pumps and the men required for their operation are dispensed with, the diver carrying about with him the air supply required for his breathing. Moreover, there is no risk of the diving outfit becoming twisted with the air conduit; and the cost of operation is extremely low.—*Scientific American.*

There are more than 200 miles of shafts, drifts, crosscuts and underground workings in the Calumet & Hecla mine.

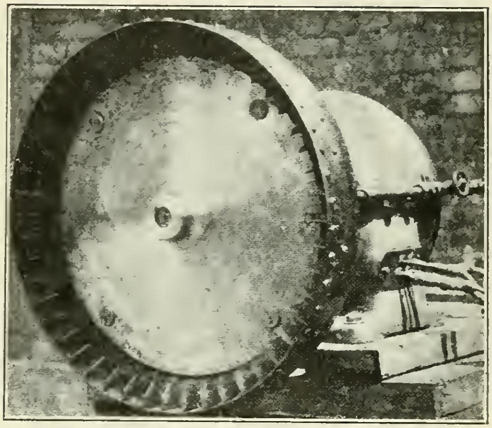


SECTION OF HUMIDIFIER.

MECHANICAL AIR HUMIDIFIER

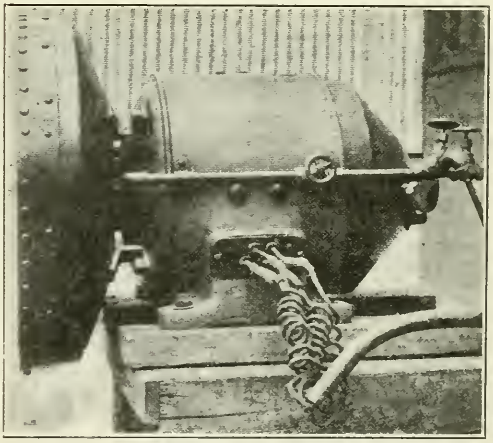
The illustrations show a device which has been developed by Mr. H. H. Clark, an engineer of the U. S. Bureau of Mines and on exhibition at the Pittsburgh testing station. By strictly mechanical means it produces a water mist almost fine enough to be called a fog.

The machine consists of a hollow wheel mounted upon the shaft of an electric motor. The wheel is provided at its periphery with spray nozzles, at its hub with an opening for the admission of water, and on its back with fan blades. The back and rim of the wheel is inclosed in a steel housing that serves as a casing for the fan, as a support for the air diffusion vanes, and as a shield for the revolving parts. When the wheel is rotated at normal speed by the motor, and water is admitted (under practically no pressure) to the opening in the hub, centrifugal force develops, at the nozzles in the wheel's periphery, an hydraulic pressure of more than 200 pounds per square inch. This pressure drives the water through the nozzles in the form of a fine spray which is seized, broken up still more, and finally carried away by the blast of air that the fan blades on the back of the wheel blow out all around the rim of the wheel between it and the surrounding housing. The diffusion vanes cause the air to be discharged in the form of a cylinder whose axis is coincident with the fan shaft.



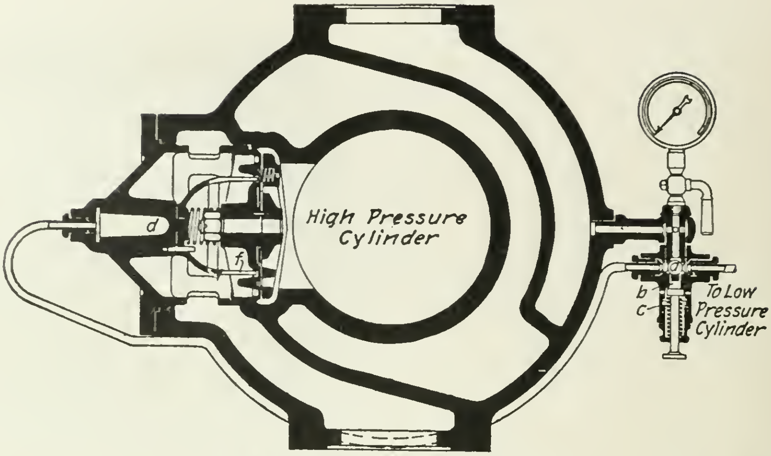
FRONT OF HUMIDIFIER.

As will be readily inferred, the mist produced is extremely fine and there is practically no dripping of solid water, but the apparatus has not yet reached its final form, and nothing can be stated as to its actual, practical accomplishment.



SIDE OF HUMIDIFIER.

What is perhaps the most extraordinary coal mine in the world, as well as the smallest, is situated on a tiny island in the Japan sea, near Nagasaki, and has just sufficient room upon its surface for the shafts and the hoisting machinery. The workings extend in all directions under the sea.



AUTOMATIC COMPRESSOR REGULATOR.

AUTOMATIC AIR COMPRESSOR PRESSURE REGULATOR

The cut shows an automatic pressure regulator for a two-stage compressor of a Swedish air plant. In the regulator valve three passages come together, the upper passage communicating with the compressed air discharge piping, while the other two are connected with devices for closing the inlet valves of the cylinders. At the point of intersection of the three passages is placed a steel ball *a* held air tight against the opening of the upper passage by the spiral spring *c* pressing against the piston *b*. When the pressure of the compressed air on the ball exceeds the pressure of the spring, the ball is forced downwards, and compressed air, flowing into the two side passages, is led through small diameter copper pipes to the inlet valves of the high and low-pressure cylinders where it acts on the piston *d;* the grip *f* forces the valve plate from its seat and opens the valve; the low pressure cylinder is now connected with the external air, and the high-pressure cylinder with the piping leading to the intermediate cooler, while the open inlet valve connects both sides of the piston, so that the compressor takes only as much power as when driven at no-load. When the air pressure has gone down enough to permit the spring to drive the ball back against the opening of the upper passage, the admission of compressed air to the piston *d* is cut off, and the compressor starts to work again. By adjusting the spring *c*, the regulator may be regulated for any desired pressure.

HOW EXPLOSIVES WORK

All commercial explosives owe their power of doing work to the expansive force of the great volume of gas into which they are converted at the occurence of the explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries, and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases: 40 per cent. dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given above.

A double-line tunnel four miles long is to be driven through the Selkirk range between Calgary and Vancouver, on the Canadian Pacific Railway in British Columbia. This tunnel will eliminate the possibility of interruption from snow slides, which have given a good deal of trouble in the Rogers Pass on the existing line.

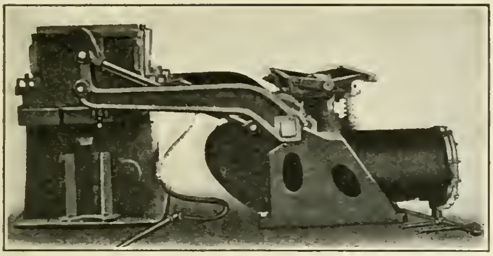


FIG. 1.

A NEW COMBINATION MOLDING MACHINE

The accompanying halftones show a new jar-ramming, roll-over and pattern-drawing molding machine operated entirely by compressed air. The story of its cycle of operations is quite completely told by the illustrations.

The pattern-plate and stripping plate are fastened permanently on the table plate of the machine, the stripping plate being placed over the pattern and resting on the pattern plate. The flask is placed over the stripping plate and in Fig. 1 it is seen on the table of the jar-ramming machine filled with a sufficient quantity of sand and in position for ramming. This is done by jumping it up and down upon the table.

In Fig. 2 the mold is being rolled over ready to be squeezed. The squeezer head is moved forward and is directly over the flask. The air is applied to the cylinder and the table plate is pressed against the squeezer head and the top of the mold is squeezed as shown in Fig. 3.

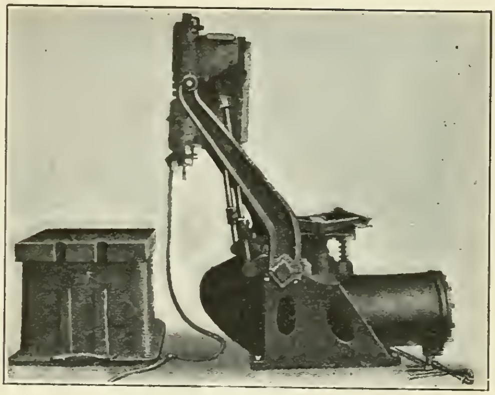


FIG. 2.

After the mold is squeezed a lever is pulled and the side lifting forks to which it is attached move upward and engage the stripping plate. In Fig. 4 is shown the stripping plate resting on the side lifting forks and when the air is released from the cylinder the pattern, which is fastened to the table plate descends. The pattern is thus stripped through the stripping plate, the squeezing head is thrown backwards and the flask is ready to be carried to the floor. The side lifting forks which support the stripping plate are lowered by means of the handle and lever to the first position ready for another mold, as shown in Fig. 5.

After the mold is squeezed the pattern can either be drawn through the stripping plate or, by drawing the handle forward, the flask can be stripped of the pattern, thus giving the choice of two different methods. In jarring, the table plate strikes upon a series of rubber and steel discs concealed in the base of

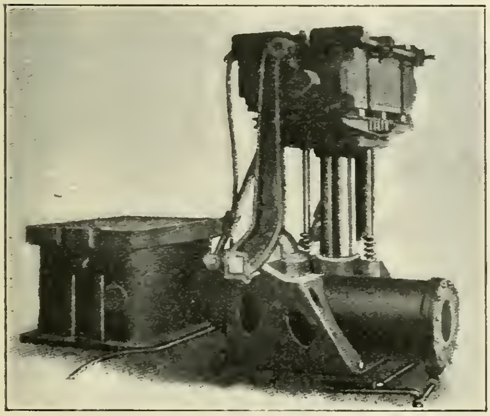


FIG. 3.

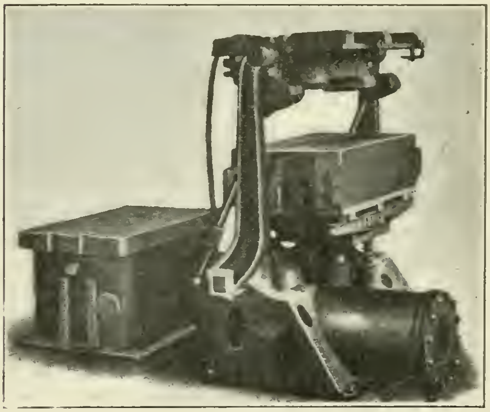


FIG. 4.

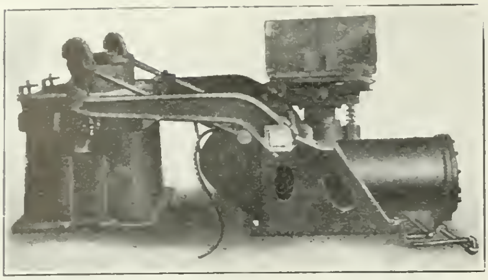


FIG. 5.

the machine. The dimensions of the table plate here shown are 30 by 45 inches, the lifting capacity is 5,000 pounds and the capacity of the roll-over is 4,000 pounds. Machines are made of various sizes both larger and smaller than this. The builders are the Herman Pneumatic Machine Company, Zelienople, Pa.

DIFFERENT WORKING PRESSUERS

This paper has to do entirely with compressors for refrigerating plants, but will be of interest to many of our readers. It was written by Mr. Robt. H. Karl, Chief Erecting Engineer Anheuser-Busch Brewing Association, St. Louis, and read before the Institute of Operating Engineers.

An ammonia compressor is constructed so that it takes in ammonia gas at a low pressure and temperature and discharges it at a higher pressure and temperature. The size and speed of the compressor, or strictly speaking, its piston displacement, is the measure of its refrigerating capacity.

If we speak of an ice machine of so many tons capacity it relates to the piston displacement per minute of the compressor. The term "tons of refrigeration" is a mis-leading expression; it is too broad and admits of different interpretations, leaving room for misunderstandings. To say that a machine has a capacity of a certain number of tons, means that a certain quantity of ammonia gas will extract an equal amount of heat units from the brine tank as would be necessary to melt so many tons of ice at 32 degrees F. In other words the latent heat of fusion is taken as a basis of refrigeration. This would be justifiable if equal results were obtained under different conditions, but this is not the case, as, under peculiar conditions, a 50-ton machine may produce only 30 tons of refrigeration, while under more favorable conditions, it might produce 70 tons of refrigeration.

With an ice machine the question is: Under what pressures is a ton of refrigeration to be produced? If a compressor discharges a certain number of cubic feet of ammonia gas with the least expenditure of work, that is all the machine can do, so its efficiency depends on the pressure of the gas entering the compressor—and the pressure against which the gas must be discharged.

A pound of ammonia can either absorb or give off a certain amount of heat by changing its aggregate state; i. e., change from a liquid to gas, or *vica versa;* and, since a cubic foot of ammonia gas increases in weight when its pressure increases, it is evident that more refrigeration can be obtained if the incoming gas is under high pressure; also, since the amount of work which must be expended depends on the pressure against which the gas is discharged, the lower this pressure is, the less work required. In other words the nearer the two pressures are kept together, the greater will be the economy and capacity. Both pressures are governed by conditions; that is, temperature of the refrigerator and the pipe surface in one case, and pipe surface and temperature and quantity of the cooling water in the other case. These conditions govern the capacity and economy and should receive proper consideration when the plant is installed. Because this is very seldom the case, the capacity and economy of many refrigerating plants are impaired. Sometimes for the sake of a few dollars' worth of pipe surface, the entire plant is crippled, while, on the other hand, the compressor is entirely too large or too small for the work it has to do, and money is thrown away in this direction.

Let us see how the suction pressure of an ammonia compression machine; that is, the pressure of the gas as it passes from the cooling coils to the compressor cylinder, exerts such a marked influence upon the capacity and also upon the economy of the refrigerating machine. We will first consider the formula I for capacity which is:

$F = .00505\ N\ M\ [V\ 1 - (tc - ta)]$ in which

F=Ice melting capacity.

N=Number of strokes per minute.

M=Weight of ammonia.
r_1=Latent heat just before evaporation.
tc=Temperature in condenser.
ta=Temperature in freezing coils.
.00505—A constant.

Since the number of strokes remains constant, it is evident that the capacity depends upon the weight of ammonia, latent heat of evaporation, temperature in the condensor and the low temperature in the freezing coils.

Referring to the table on Properties of Ammonia, it is seen that as the suction pressure is increased, the corresponding latent heat becomes less, and the corresponding temperature rises; consequently the latent heat, temperature in condenser and freezing coils change but little with different suction pressures and the capacity is practically proportional to the weight of ammonia circulated. Take, for instance, a suction pressure of 18.45 pounds absolute. The weight of a cubic foot of gas at that pressure is .0690 pound, while at a pressure of 38.55 pounds, a cubic foot weighs .1384 pound; or twice as much, and as the same volume of ammonia gas passes through the compressor in a given time, no matter what the pressure is, the weight of ammonia circulated is proportional to the weight of the vapor per cubic foot. Then, with the greater suction pressure the machine will circulate double the amount of ammonia that it will with the lower pressure and the capacity at the higher suction pressure will be nearly double than at the lower pressure.

It requires more aggregate power to operate the compressor at a higher suction pressure, but the increase in power is not proportional to the increase in capacity, because the power consumed per ton decreases as the suction pressure is raised. The power required is proportional to the heat delivered to the condenser minus the heat taken from the cold body, and the capacity is proportional to the heat taken from the cold body; therefore the ratio

$$\frac{\text{Horsepower}}{\text{Ice melting capacity}}$$

is proportional to the

$$\frac{\text{Heat delivered to the conderser—heat taken from body cooled}}{\text{Heat taken from body cooled.}}$$

The only effect on the heat delivered to the condensers of raising the suction pressure is to lower the temperature at the end of compression. The only effect on the heat taken from the body cooled is to decrease the latent heat of the liquid just before vaporization and to increase the temperature in the freezing coils, but since the temperature in the freezing coils increases faster than the latent heat decreases, the net effect of raising the suction pressure is to increase the heat taken from the cold body. Since the heat delivered to the condenser is decreased and the heat taken from the body is increased, the fraction

$$\frac{\text{Heat delivered to condenser—heat taken from body cooled}}{\text{Heat taken from body cooled}}$$

and the ratio

$$\frac{\text{Horsepower}}{\text{Ice melting capacity}}$$

is decreased by raising the suction pressure, which brings out the important fact that increasing the suction pressure increases both the capacity and economy of the machine.

The following examples will perhaps serve to make things a little clearer. We will take a certain size compressor; for instance, a so-called 50-ton compressor, to illustrate the amount of refrigeration which may be obtained under different conditions.

Case 1. For the sake of simplicity, consider a saturated-gas compressor working without superheating. A 12-inch diameter by 24-inch stroke double-acting machine, at 70 revolutions per minute, is rated at 50-tons. If this compressor works with a suction pressure of 10.31 pounds against a condenser pressure of 200 pounds (gauge pressure) each cubic foot of ammonia at 10.31 pounds pressure would weigh .0921 pound, and each stroke of the piston displaced 1.57 cubic feet of gas, the weight of which at that pressure would be .1445 pound. The example then would read like this: $F. = .00505 \times 70 \times 2 \times .1446 (560.39—(100—8) \times .80 = 37.02$ tons, while the horsepower would be about 76.2. So this machine would fall short of its rated capacity about thirteen tons.

Case 2. If the same compressor is operated with a suction pressure of 27.28 pounds and a condeser pressure of 170 pounds, the weight of ammonia discharged per stroke will be .2366 pounds, and at the same speed the capacity of the compressor will be: F. = .00505 × 70 × 2 × .2366 (546.88—(91—14) × .80 = 62.88 tons; horsepower about 83.2. This example shows the foolishness of buying a machine of 50-tons capacity without knowing under what conditions it will have to work, for this compressor will develop its rated capacity only.

Case 3. With a suction pressure of 18.68 pounds and a condenser pressure of 180 pounds at the same speed and efficiency, and the example will read like this: F. = .00505 × 70 × 2 × .1903 (553.04—(94—4) × .80 = 49.81 tons; horsepower about 80.4.

Case. 4. The same compressor may, however produce a great deal more. In cooling wort in a brewery where the suction pressure is 44.72 pounds and the condenser pressure 180.43 pounds, the weight of ammonia discharged per stroke is ,3295 and the result is: F. = .00505 × 70 × 2 × .3295 (531.96—(94—30) × .80 = 88.15 tons; horsepower required about 91.2.

From the above examples it will be seen that the effects of increasing the suction pressure on the same machine, with same speed, are marked. Comparing, for instance, Case 3, where the compressor is working at its rated capacity of 50-tons of refrigeration, with about 1.6 horse-power per ton, with Case 1, where the same machine with the same speed, etc., is working at a lower suction pressure, with 2 horsepower per ton, it is seen that in Case 1 the capacity is reduced 26 per cent. while the horsepower per ton is increased 25 per cent.

Now, comparing Case 3 with Case 2 it is seen that an increase in the suction pressure from 18,68 pounds, Case 3, to 27.28 pounds, Case 2, results in an increase in the capacity of the compressor, at the same speed, etc., to 62.88 tons—an increase of practically 12 tons, or 26 per cent., while the horsepower per ton has decreased from 1.60 to 1.24, or about 22½ per cent. less power per ton.

In comparing Case 2 with Case 1 we find that raising the suction pressure from 10.31 pounds to 27.28 pounds resulted in increasing the capacity of the compressor 70 per cent. and power requirements only 9 per cent. In other words the extra 25.8 tons refrigeration are obtained at an expenditure of only 7 horsepower.

The volumetric efficiency assumed in this case is 80 per cent, which agrees closely with results obtained in practical tests. In some cases, of course, it is much more and in others less; depending upon how well the machine is designed and operated as well as the skill of the operator in keeping the machine in first-class condition. The principal and unavoidable losses are self reduction of the liquid and suction depression; other losses being in superheating, leaking of piston and valves, and excessive clearance, which can be reduced to a minimum.

In the above examples 20 per cent. was added to the theoretical horsepower to allow for losses of friction, etc.

Operate your machine with as high a suction pressure and low head pressure as possible to maintain your required temperatures. Make use of your indicator and learn to analyze the cards and you will be surprised at the defects discovered. An indicator card taken from an ammonia compressor indicates the work performed by the machine. By comparing the heat curve with the isothermal and adiabatic curves, the excessive clearance and re-expansion losses are indicated, as well as leaky or defective valves. Calculations can be made to show the extent of these losses. All of these items are very important if the machine is to be operated at its full efficiency, and the indicator should therefore be used frequently on an ice machine, as it tells immediately if there is anything wrong with the compressor or with the system in general. It is not necessary to make exhaustive and expensive tests on an ice machine, as the simple indicator card tells the whole situation.

The miner's inch is defined by California law as equivalent to 1½ cu. ft. of water per minute through any aperture or orifice.

A big factor in Winnipeg's industrial future, and one that will rank Winnipeg high as a manufacturing center, is the completion of the municipal electric development scheme, whereby 60,000 horsepower is now available for power for factory purposes. This power, which can be increased as necessity arises, is being delivered at cost, and naturally proving a considerable stimulus to industrial activity.

COMPRESSED AIR
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EVERYTHING PNEUMATIC
Established 1896

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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Vol. XVII. DECEMBER, 1912. No. 12

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CHINESE AIR RECEIVERS

The account given on another page of our present issue of the oxy-acetylene welding of the successive joints of a long high pressure gas pipe line in California, cannot fail to have an interest to those who have to do with piping for compressed air service. It may be that while the economy and success of this pipe welding is conceded for work of a permanent character, such as is the laying of a gas main, it would not be equally applicable for compressed air lines, for these are often temporary and have to be taken apart to be sold when the job is done, or to be used somewhere else by the same owners. Many such pipe lines, even of quite large size are only for a year or so, but many are laid for much longer or for absolutely permanent service, and as to the use of the welding operation in any given case circumstances must determine.

But there is another view of this welding operation and its adaptabilities which is worth considering. It must be remembered that in the case recorded in the article referred to the work was all done in the street with makeshift contrivances to facilitate the work, and it is inevitably suggested that in a well equipped modern factory with everything arranged for comfort, convenience and economy the welding operation might have a much more extensive application in manufacturing processes and upon work surely of the most permanent and enduring character.

May not the day soon come—for things succeed each other rapidly now—when we will realize more completely the inefficiency of, and the absurd waste of material in, the riveted joint, and may not later the time come when riveting will be abandoned and samples of it become an exhibit in the museums? The writer lately stood with a young lady friend beside a high pressure steam boiler where the rivets were a protuberant feature. "How strong that boiler must be with so many big rivets in it," she remarked. "Why, my dear girl, every rivet represents a hole in the sheets and that part of the boiler is the weakest instead of the strongest part of it." This, of course, is always true. With double the thickness of metal and the added weight of the rivet heads the joint is the weakest part and weakens the entire structure by 25 or 30 per cent. And that is not all. The sheet is 25 or 30 per cent. thicker over its entire surface, and the same percentage heavier, than it need be to equal the strength of the joint.

If we are in order we here make a motion to the effect that hereafter rivets shall be dispensed with and instead the welding of the edges of sheets to each other be employed wherever practicable.

And where is there a better place for such welding than in the making of air receivers? The receivers are the most defective detail of compressed air practice to-day, and that in other ways than as to the riveting, but with these we have here nothing to do. Getting rid of the rivets and making receivers of uniform and sufficient and reliable strength throughout should be a desirable achievement.

And then the Chinese part of it, suggested in our title above. It is well known that the Chinese have never used barrels as packages for their merchandise, and the reason that has been assigned for it is that they have never found a way of putting in the last head of the barrel without having a Chinaman inside to hold it up.

It is rather singular that the same charge can be brought against us and the way we make our air receivers, especially those of the smaller sizes which are the most numerous. These receivers are made with dished heads, which is evidently proper, and one head is placed with the convex face outward, which also is proper, best for both strength and looks, while the other head is set with the bulge of the head inward, a thing disgusting to any one with correct mechanical instincts, until he has become too familiar with it, and the only assignable reason for it is that they can't rivet in the head the other way without some one inside to insert and hold the rivets.

In our August issue was described how one of these receivers exploded by the sudden outward buckling of the Chinese head and the tearing out—not shearing—of the rivets. Only a short time later another receiver in the same neighborhood exploded in the same way, showing at least where was the weakest place in it.

This weakness and the other weaknesses of the too familiar type of air receiver may be eliminated by abandoning entirely the use of rivets. Weld up the shell and weld in—or on —the head, placing them both in correct position and making "every part as strong as the rest." We need not here go into the details of the work in any particular. The scheme is entirely practicable, and the one who first goes into it fully equipped for the business cannot fail to make of it a complete success and contribute to the safety of those who have to do with air or other fluids under pressure.

NEW BOOK

Energy and Velocity Diagrams from Large Gas Engines; Their Use and Layout, by Paul L. Joslyn, 70 pages, 6 by 9 inches, 62 diagrams. Gas Engine Publishing Company, Cincinnati. Cloth, $2.00.

For cost of construction, and, if for nothing else, for the avoidance of costly reconstruction, the designer of large gas engines has to consider many things which on small engines are often left to be worked out after a first engine has been built. In this book the author gives the methods of laying out energy and velocity diagrams for large engines operating on blast furnace, producer or natural gas, with instructions as to their use, etc. The data given are the result of actual designing of this character on some of the largest engines built in America and Europe.

TRADE PUBLICATIONS

Positive Pressure Blowers, Vacuum Pumps and Exhausters, Albert J. Kelting Engineering Works, Brooklyn, New York, 16 pages, 6 by 9 inches. Illustrated description of line of blowers and compressors.

Pump Slippage, its Cause and Prevention, Hill Pump Valve Company, Chicago, 24 pages, 6 by 9 inches, illustrated, inserted folded blue print diagram. The discussion of pump slippage leads to the matter of defective valves and a description of the Hill pump valves.

The Indicator Book, Trill Indicator Company, Pa., 48 pages, 6 by 9 inches, numerous cuts. The indicator and all appurtenances are described, and instructions as to manipulation are given, with many indicator cards from different types of engines and samples of the different errors of practice likely to occur.

Mallet Articulated Locomotives, Record No. 72, Balwin Locomotive Works, Philadelphia, 44 pages, 6 by 9 inches, folded lengthwise. This interesting line of locomotives is described, with examples of different designs for special service, and beautiful illustrations of engines complete and ingenious sectional views showing internal details. The weight of the heaviest engine shown is 406,600 lbs. and the greatest tractive force 97,200 lbs.

Manila Rope, by C. W. Hunt, 52 pages, 6½ by 9½ inches, liberally illustrated. This pamphlet contains a great variety of valuable information upon the general subject of ropes, rope driving and power transmission with formulas, tables and data useful in mill engineering. C. W. Hunt Company, 45 Broadway, New York.

De Laval Steam Turbines, Multi-Stage Type, De Laval Steam Turbine Co., Trenton, N. J., 120 pages, 6 by 9 inches, profusely illustrated with halftones. This is more than an ordinary trade catalog. A third or more is devoted to a discussion of the "speed compromise" problem, and the relative advantages of the several fundamental types of turbines are discussed. The book contains a chart accompanied by a steam scale by means of which the energy available from the expansion of steam between given limits can be read off directly as heat units, velocity of steam in feet per second, duty in foot pounds per thousand pounds of steam, and pounds of steam consumed per horsepower hour. Detailed descriptions of the De Laval turbines are given. Sent upon request to those interested by the De Laval Steam Turbine Company, Trenton, N. J.

REGULATIONS FOR WORKERS IN COMPRESSED AIR

At the International Congress of Hygiene and Demography, recently held in Washington, D. C., papers discussing the nature of the disease and its prevention were presented both by physicians and engineers, and the following notes are taken from such a paper by Mr. Henry Japp, of S. Pearson & Son, Inc., New York.

In order to safeguard properly the interests of the workmen under compressed air, it is necessary to maintain strict discipline during the working hours. In the construction of the East River tunnels the following set of regulations, written in English, German, Italian, Slavish, Hungarian and Polish, were posted in conspicuous places. In addition to an enforcement of these rules, men working for the first time under compressed air were kept under close medical observation for a probationary period, and if there were any evidence of physical weakness the workman was not allowed to continue work under air.

REGULATIONS FOR MEN WORKING IN COMPRESSED AIR.

(1) All men must be examined by the medical officer before conmmencing work in compressed air, and must not enter the airlock until passed by him. His advice should be taken in all cases of illness or accident, which should be reported to him immediately.

(2) All men must wear the doctor's pass badge where it can be seen by the timekeeper and locktender.

(3) No man should enter the airlock when sick or with an empty stomach.

(4) After an attack of illness, all men must report to the medical officer before returning to work in the tunnels.

(5) No nuisance will be permitted in the tunnels. A watercloset on the surface is provided for the use of workmen. The bladder should be relieved before entering the tunnels, and all workers are strongly advised to see that their bowels are opened every day.

(6) All men are advised to use intoxicating liquors sparingly or better, not at all, and to drink water sparingly while in the tunnels.

(7) Get fully 7 hours' sleep every 24 hours, if possible.

(8) While in the lock, as the pressure is raised, it is recommended to clear the passage between the ears and throat by continued swallowing.

(9) After coming out of the lock, all men are advised to drink warm coffee freely and to put on dry, warm woolen clothing.

(10) Avoid exposure to cold and do not exercise unduly for one hour after leaving the lock.

(1)) Smoking in compressed air is dangerous and not permitted.

PROPOSED RULES.

With the view of obtaining authoritative information on the subject, the commissioner of labor of the State of New York called upon those interested in compressed air work to submit their views to aid him in drafting a law regulating employment under compressed air. In answer to this request the following set of rules was submitted by a self-organized body of twenty-one members, including prominent engineers, doctors and contractors:

(1) *Medical Examination.* — Before being allowed to start work in compressed air, all men should be examined and pronounced physically fit by the medical officer.

In event of a man being absent from work for more than three days owing to a sickness, he shall not resume work in compressed air until he has been re-examined and passed.

When a man is suffering from an ailment he should report himself to the medical officer, whose advice he shall follow.

(2) No alcoholic liquors will be allowed on the work.

(3) The workmen shall be supplied with hot coffee free of charge.

(4) The contractors will also provide for the men warm dressing rooms, bath room with hot water and a medical airlock.

(5) *Analysis of Air.*—Sufficient air shall be pumped into tunnel heading so that the percentage of CO_2 shall not be greater generally that $^1/_{10}$ of one per cent. above that of the air being compressed, and in order to insure good ventilation, the air supply pipes shall be carried as near to the face as may be practicable and necessary.

(6) Persons working in compressed air must be able to communicate with the power plant on the surface at any time through suitable signal apparatus.

(7) *Periods in Various Pressures.*—Up to 20-lb. gauge pressure, two five-hour shifts at the face may be worked.

From 20-lb. up to 32-lb. gauge pressure, eight-hour shifts may be worked with half an hour off for lunch.

From 32-lb. to 40-lb. gauge pressure, six hours at the face shall be worked, divided into two shifts of three hours each.

The periods to be taken for coming out of the various pressures shall be as per table:

Pressure between locks to be approximately half the gauge pressure at the face. The men will be held responsible for the due observance of the above rules.

An abstract of the amended New York law, which went into effect September 1, 1912, was printed in the issue of COMPRESSED AIR MAGAZINE for June, 1912.

ONE-STAGE DECOMPRESSION.

15 lb. gauge pressure	1 to 3 min
20 lb. gauge pressure	3 to 4 min.
25 lb. gauge pressure	5 to 8 min.
30 lb. gauge pressure	10 to 15 min.
35 lb. gauge pressure	15 to 20 min.
40 lb. gauge pressure	25 to 30 min.

TWO-STAGE DECOMPRESSION.

25 lb. gauge pressure, outer lock, 3 to 4 min.
30 lb. gauge pressure, outer lock, 6 to 8 min., with five minute interval between locks.
35 lb. gauge pressure, outer lock, 8 to 10 min., with ten minute interval between locks.
40 lb. gauge pressure, outer lock, 12 to 15 min., with fifteen minute interval between locks.

NOTES

Four thousand tons of coal were put into the "Olympic" in 14¼ hours at Southampton recently. This is a record coaling feat for the port and a world's record. Thirty-two gangs of men were employed, an average rate of 288 tons per hour being maintained throughout the night.

Baltimore is losing $102,200 a year from underground leaks in water pipes. This declaration was made by Water Engineer Whitman, who will include in his estimate of 1913 expenses of the Water Department a request for $15,000 for the establishment and maintenance of a sub-department to detect and repair these leaks.

Thirty years ago the value of natural gas produced in the United States was less than $500,000. There are now nearly 30,000 wells, producing annually more than 500,000,000,000 cubic feet of gas, valued at nearly $75,000,000. Last year the output was 508,353,241,000 cubic feet, Pennsylvania being the greatest consumer, with 154,475,376,000 cubic feet.

The famous greenheart tree of British Guiana is said to be the strongest, toughest and most durable wood in the world, and it has therefore been selected by the army engineers in charge for the construction of the miter sills in the great lock gates of the Panama canal. This wood is best able, it is said, to resist the dreaded teredo. so prevalent in tropical waters.

The smoke nuisance costs the United States $500.000.000 a year, is the estimate given by the department of industrial research at the University of Pittsburgh. This damage consists in the defacement of buildings, tarnishing of metals, damage to merchandise, injury to both human and vegetable life, increased cost of housekeeping and loss to manufacturers through the imperfect combustion of coal. The loss in Chicago alone is estimated at $50,000,000 a year.

Unless a dog has long, shaggy hair a vacuum cleaner will suck out the fleas "as clean as a whistle." It has been actually tried with excellent results.

The Ingersoll-Rand Co. is shortly going to bring out a new drill, to be called "The Bull Moose," which strikes us as being a very good name for a hard-slugging rock drill. While we are on this subject of nomenclature, it will be interesting to note that the Mexican miners call the jack-hammer drill the *chicharra,* the cricket. The operator is coming to be known as the *chicharrero.—Engineering and Mining Journal.*

It has been known for some time that gases will pass through metals when they are highly heated, thus platinum at a red heat will allow air to pass through it. Iron is also permeable for hydrogen when hot, and even when cold to a certain degree. More recently, Charpy and Bonnerot show that nitrogen does not penetrate iron below a temperature of 800 deg. Cent. Hydrogen passes more easily, and at a temperature of 500 degrees a considerable action is noticed.

Australia has many valuable hardwoods and among them one of the most remarkable is yate. It has been found that this is the strongest timber known. Its average tensile strength is 24,000 pounds to the square inch, equalling that of good cast iron. Many specimens are much stronger and one was tested up to 17½ tons to the square inch, which is equal to the tensile strength of wrought iron. The tree grows to a maximum height of 100 feet, and has sometimes a diameter of two and one-half or even three feet.

The Russian destroyer Norik, is stated to have exceeded 36 knots on her official trials last month. The vessel, which is 336 feet long by 31 feet 6 inches beam, is of 1,280 tons displacement, and was built at St. Petersburg, the machinery consisting of A. E. G. turbines and oil-fired boilers, being supplied by the Vulcan Company, of Stettin. The designed speed was 35 knots, with 36,000 shaft horsepower, but both have been considerably exceeded. This vessel, should the report be correct, is the swiftest destroyer afloat.

In 1910 the mines of the transvaal employed 257 steam-driven air compressors having 100,291 hp., there being an average of three 50-drill compressors on each mine. Formerly, all the air compressors were steam-driven, but now electric energy is furnished to all the mines by the Victoria Falls & Transvaal Power Co., Ltd., and electricity for air compressors has superseded steam.

The formal opening of the Livingstone Channel, 12 miles in length, through the shoal waters of Limekiln Crossing at the mouth of the Detroit River, occurred, with imposing ceremony, on October 19. This deep channel has been excavated through solid limestone rock and affords a straight and safe passage for the immense vessel traffic of the Great Lakes. More vessels and a greater tonnage pass through it than any other waterway in the world. This channel, 4⁴/₅ miles of which lie in Canadian waters, has been some years under construction by the United States Government at a cost of about $10,000,000.

It has often been observed on return airways, where the air is warm and dry, that the lamps do not burn so brightly and the workmen become dry and thirsty. Tabe explains this by saying that the parched air absorbs the moisture from the body, and unless they have ample drinking water, their blood becomes thick and hot, resulting in feverish, painful lassitude. The same warm air, before reaching the lamps, has been absorbing water in its journey, and is thus so heavily charged with watery vapor that its oxygen is diluted, which results in dull and sickly lights.

A writer in "Science" tells of an ingenious little skiff, about two inches long, which he constructed and provided with a piece of soap for the motor. The boat was of wood paraffined to repel the water. The soap formed the stern board of the skiff. The boat was placed in still water in a bathtub, and began to move as soon as the water came in contact with the soap. After gathering headway it reached a velocity of two inches per second. The power was derived from the potential energy of the surface water film set free by the diminution of surface tension, this reduction being due to solution of the soap.

Our whistle is blown by compressed air. Sometime ago the compressor was down for repairs and it began to look as though curfew would not blow that night, when I happened to have a thought. I had a motor driven triplex water pump running against 75 lb. pressure and the top of the air chamber had a ¾-in. pipe tapped in it. I connected a whistle to this, stopped the pump, drained the air chamber, then started the pump again and had 75 lb. of air with which to blow the whistle. —*Practical Engineer.*

The molecular aristocrats of the chemical sugar sphere and the molecular anarchists from the plain of nitroglycerine are nearly as far apart as kings and slaves were, but an exchange reports that dynamite is to become a new form of plow, especially in the South. A Southern farmer conceived the idea of turning things upside down in this new way and he found that the size of the crops increased to such an extent, because the deep sub-soil was loosened up, that it paid for all the dynamite and more. One manufacturer of explosives sold 500,000 pounds to farmers in 1908, in 1911 he put out 3,000,000 pounds for this purpose, and this year it is believed the output will be 5,000,000 pounds.—*Louisiana Planter.*

A mining-machinery salesman recently walked over to a city rock pit where rock for making roads was excavated and crushed. He gave the superintendent a cigar and began talking rock drills. The drills in use there were manufactured by the company he represented, but were apparently of extremely antique pattern. The young salesman with characteristic enthusiasm and fresh from talking with mine superintendents, began to tell the city official of a very efficient one-man drill that was making records for itself. He claimed that if the city would install the improved type, at least one-half the present force of men could be dispensed with. At this point the city official spoke up; "Young man," he said, "if you can give us a drill that will require more men to operate and make more jobs that aren't too hard, we'll be interested, but this new machine's not in our line.—*Engineering and Mining Journal.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 1.

1,039,700. GLASS-BLOWING MACHINE. Geo. C. Crawford, Bartlesville, Okla.

1,039,755. OPERATING MECHANISM FOR FRICTION-CLUTCHES. Charles B. King and Clarence B. Weston, Marion, Ohio.

1,039,757. COMPRESSOR. John C. Kitton, Elgin, Ill.

1,039,809. TUNNELING-MACHINE. Lebbeus H. Rogers, New York, N. Y.

1,039,840. SAND-BLAST MACHINE. John J. Strasser, Chicago, Ill.

1. The combination of a reservoir for comminuted material, a substantially horizontal tubular member for the outward flow of the comminuted material. said tubular member being arranged at the lower part of the reservoir and having an opening to the outside air and also an opening within the reservoir for the admission of the comminuted material, said last mentioned opening being on the under side of said tubular member whereby it is prevented from being choked by the material within the reservoir.

1,039,842. PNEUMATIC PUMP. Martin S. Swanstrom, Chicago, Ill.

1,039,958. AIR-LIFT. Frank J. Kimball, Los Angeles, Cal.

1. An air-lift comprising, in combination with a well casing, a tubular pump head connected to the lower end of said casing, and provided with an air chamber, means for supplying compressed air to said chamber, and a plurality of nozzles extending upwardly from said chamber and opening at their lower ends into said chamber and opening at their upper ends into the interior of the tubular pump head at different levels.

1,039,971. DOWN-HOLE HANDLE-SUPPORTED ROCK-DRILL. John George Leyner, Denver, Colo.

1,039,972. AIR-CONTROLLING VALVE FOR ROCK-DRILLING ENGINES. John George Leyner, Denver, Colo.

1,040,112. PNEUMATIC WEIR-SHUTTER. John Ashford and Stephen Leggett, Amritsar, India.

1,040,114. PNEUMATIC-CUSHIONED WHEEL. Irwin H. Babcock, De Ruyter, N. Y.

1,040,123. OZONIZER. Harold E. Beck, Chicago, Ill.

1,040,218. PROCESS OF PURIFYING CRUDE GAS. Howard Lane, Birmingham, England.

The herein described process of purifying crude gas which consists in first compressing the gas to a pressure of several atmospheres and then causing the gas so compressed to flow in contact and concurrently with an oppositely flowing stream of water through a mass of comminuted neutral material.

1,040,221. FLUID-OPERATED DRILL-STEEL-GRIPPING VISE FOR DRILL-BIT-SHARPENING MACHINES. John George Leyner, Denver, Colo.

1,040,222. AIR-BRAKE MECHANISM FOR LOGGING-TRAINS. George H. Libby and Harry L. Turney, Portland, Oreg.

1,040,231. PUMP. James M. McWilliams, Leesville, La.

1. A pump including a submerged cylinder, an air pump communicating with said cylinder, a discharge pipe communicating with said cylinder, and having a check valve, an outlet valve in said discharge pipe, a spring controlled lever adapted to normally hold said outlet valve closed, and a connection between said lever and the air pump piston serving to open said outlet valve upon movement of the piston to operative position.

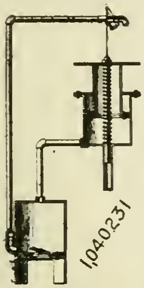
OCTOBER 8.

1,040,302. PNEUMATIC - DESPATCH - TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass.

1,040,311. AIR-SUPPLY DEVICE FOR FIREMEN. James D. Halloran, New York, N. Y.

1. In an air supply device, the combination with fire hose having a nozzle, an air suction device exteriorly connected with the said nozzle at the discharge end thereof for drawing in air by the passage of the water through the nozzle, a main air supply pipe connected with the said suction device for drawing in air through the air supply pipe independent of the said fire hose, tapping means connected with the said main air supply pipe for tapping the latter for air, and distributing means connected with the said tapping means for distributing the tapped air to the firemen for breathing purposes.

1,040,350. APPARTUS FOR PRODUCING FLUID-PRESSURE. Joseph F. Keys, Gypsum, Kans.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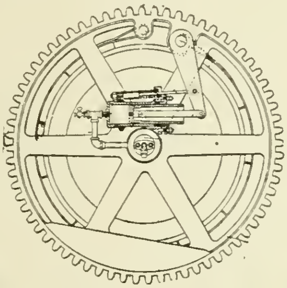
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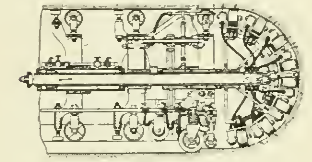
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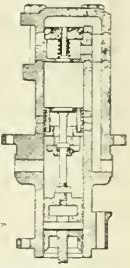
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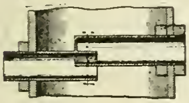
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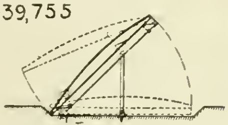
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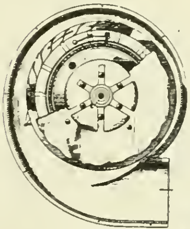
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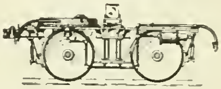
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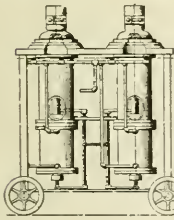
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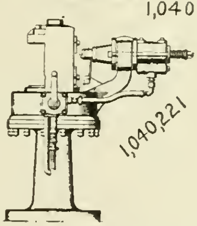
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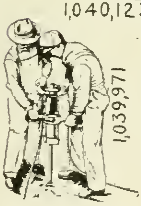
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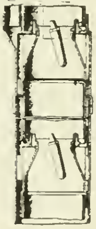
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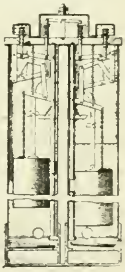

1,039,842

Pneumatic Patents, October 1.

1,040,356. APPARATUS FOR DETERMINING THE AMOUNT OF CARBON DIOXID IN THE AIR. Louie E. Knott, Boston, Mass.

1,040,434. AERIAL-VEHICLE STABILIZER Laurence O. Schopp, St. Louis, Mo.

1,040,499. AIR - PURIFYING APPARATUS. William G. R. Braemer, Camden, N. J.

1,040,544. ROCK-DRILL. Charles A. Hultquist, Los Angeles, Cal.

1,040,641. VACUUM-CREATING APPARATUS. Mark F. Coyle, Corry, Pa.

1,040,643. APPARATUS FOR INFLATING ROTATING TIRES. Richard E. Darnley, Huddersfield, England.

1,040,679. METHOD OF MINING COAL AND OTHER MINERALS. Joseph H. Hoadley, New York, N. Y., and Walter H. Knight, Portsmouth, R. I.

1. The method of mining coal and other minerals, which consists in comminuting the said mineral in the act of taking it from its bed, depositing the product in the path of a swiftly moving body of air, drawing the said product through the agency of said air into a closed conduit, wetting the product, conveying it while in this condition to a separating chamber, withdrawing the air from the wetting product, and then permitting the mineral to separate from the water by the operation of gravity.

1,040,766. COMPOUND VALVE AND STARTER. Charles C. Roth, Indianapolis, Ind.

1. In a valve to prevent back pressure through pipes supplying air under pressure to the cylinders of explosive engines, a cylindrical valve case having a reduced discharge end in which a valve seat is formed, an outwardly opening valve in said seat, a spring to normally seat said valve stem extending inwardly of the case, a cap on said case, a piston mounted in the case and seated against the cap and a second spring weaker than said first spring to press the piston against its seat in the cap.

1,040,773. AIR-DOUCHE. August Schaeffer, Frankfort-on-the-Main, Germany.

1,040,846. FLUID-PRESSURE BRAKE FOR RAILWAY-CARS. Edward A. Barber, York Pa.

1,040,873. AUTOMATIC AIR - RETAINER. Leonard L. Brown, Clifton Forge, Va., and John Frankling Smith, Ronceverte, W. Va.

1,040,886. PROCESS OF RECOVERY OF VOLATILE LIQUIDS. Georges Claude, Paris, France.

1. A process of recovery by liquefaction, volatile liquids contained in the condition of dilute vapors in large volumes of air or gas, which consists in compressing the air or gas containing the vapors to be recovered, submitting it to a preliminary cooling by means of cold water, then circulating it in indirect contact with air or gas previously expanded and cold in order to liquefy the volatile portions, so that the liquids formed run toward spaces which are warmer than those in which they are liquefied, finally allowing the air or gas thus freed from volatile matters to expand, and using it for cooling successive quantities of the air or gas containing the volatile vapors to be recovered.

1,040,981. EXHAUSTER OR COMPRESSOR FOR GASES, ALSO APPLICABLE AS AN EJECTOR-CONDENSER. Wilfred Hunt, Hillhead, Glasgow, Scotland.

1. An air or gas exhauster or compressor or an ejector-condenser, comprising a stationary direc-

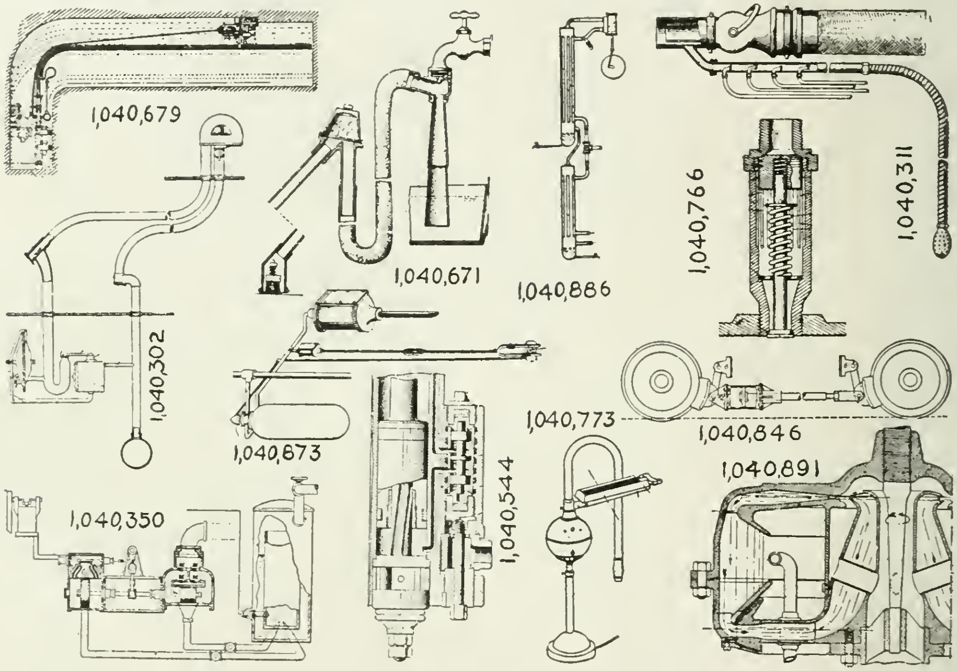
tor and an ejector device, a rotary centrifugal returner arranged to receive an extraining liquid from the ejector, subject the same to centrifugal action and pressure to effect the separation of the entrained gases from the liquid and discharge said liquid to the stationary director, so that said liquid travels a circuit, in combination with means for maintaining the amount of the entraining liquid, an entrance for entrained air or gas and a discharge port for the separated air or gas.

OCTOBER 15.

1,041,057. PNEUMATIC-HAMMER DEVICE. LOUIS G. FISCHER, Harrisburg, Pa.

1,041,091. AIR-BRAKE APPARATUS. OSCAR JOHNSON, Chicago, Ill.

1,041,125. PNEUMATIC ACTUATING UNIT. NELS MAGNUSON, Fort Wayne, Ind.



PNEUMATIC PATENTS, OCTOBER 8.

1,041,156. METHOD FOR ASCERTAINING THE LOCATION OF LEAKS IN UNDERGROUND FLUID-PRESSURE PIPES. GEO. V. PAYNE, Chicago, Ill.

1,041,323. APPARATUS FOR REMOVING MOISTURE FROM AIR. JOHN B. MILES, Philadelphia, Pa.

1,041,336. PNEUMATIC - PRESSURE GAGE. OLE OLSEN, Oakland, Cal.

1,041,391. AIR-BRAKE COUPLING. OLIVER P. WILHELM, Michigan City, Ind.

1,041,421. PROCESS FOR OZONIFYING. CHAS. S. BRADLEY, New York, N. Y.

The process of ozonifying, which comprises effecting an ozonifying electric discharge in a gas at a pressure materially below atmospheric, whereby the impedance to the travel of the charged particles of the gas is diminished

1,041,487. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. AUGUST DE KLEIST, North Tonawanda, N. Y.

1,041,505. CENTRIFUGAL COMPRESSOR. SANFORD A. MOSS, Lynn, Mass.

1,041,511. CENTRIFUGAL COMPRESSOR AND PUMP. RICHARD H. RICE and SANFORD A. MOSS, Lynn, Mass.

1,041,529. MEANS FOR REGULATING CENTRIFUGAL COMPRESSORS. RICHARD TROGER, Charlottenburg, Germany.

1,041,569. PERCUSSION - TOOL MACHINE. FRANZ BADE, Peine, Germany.

1,041,634. VACUUM-PRODUCER. WILLIS L. KING, Phenix, R. I.

1,041,640. SUPPLYING FUEL AND WATER TO BOILERS. HERMANN LEMP, Lynn, Mass.

1. In combination, a vapor generator, a burner for heating the fluid in the generator, means for supplying fluid to the generator, a controller for the fluid supply, means for supplying fuel to the burner, a controller for the fuel supply, a source of compressed air supply, and a regulator responsive to variations in the pressure in the generator for regulating the supplying of compressed air from said source to said controllers to cause the latter to vary the supply of fluid and fuel to the generator and burner respectively.

1,041,661. BRAKE DEVICE FOR ROLLING-MILLS. ADOLF ALEXANDER KARL NOWAK, Bous-on-the-Saar, Germany.

3. A rolling mill having a mandrel rod, a compressed air device for advancing the same, and a fluid brake employing a non-compressible fluid, co-operating with the mandrel rod to halt its advance at a predetermined point, substantially as described.

1,041,693. DUPLEX AIR-COMPRESSOR. SIMON K. STEFFY, Harrisburg, and HOWARD H. NAYLOR, Marietta, Pa.

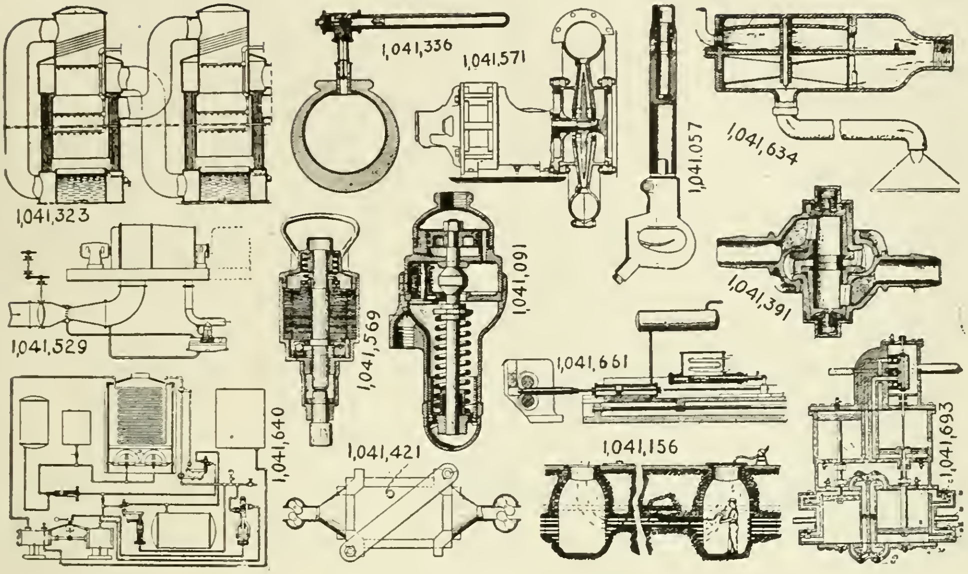
OCTOBER 22.

1,041,744. PNEUMATIC TRACK-SANDER. ANTHONY S. CONTI, Chicago, Ill.

1,041,860. MUSIC-SHEET-GUIDING DEVICE. JAMES O'CONNOR, New York, N. Y.

1,041,861. TEMPO - REGULATOR. JAMES O'CONNOR, New York, N. Y.

1. A pneumatically operated musical instrument including in combination, a movable member for modifying the musical effect controlled



Pneumatic Patents, October 15.

by a perforation or group of perforations in a music sheet and plurality of pairs of oppositely acting pneumatics the members of each pair of which act conjointly, all operatively connected with said movable member.

1,041,939. AIR COMPRESSOR AND PUMP. George P. Aborn, Boston, Mass.

1,042,055. VACUUM-CLEANER. Joseph Theisen, Grand Rapids, Mich.

1,042,106-7. LIQUID-STORAGE SYSTEM. Horace E. Grant, Pittsburgh, Pa.

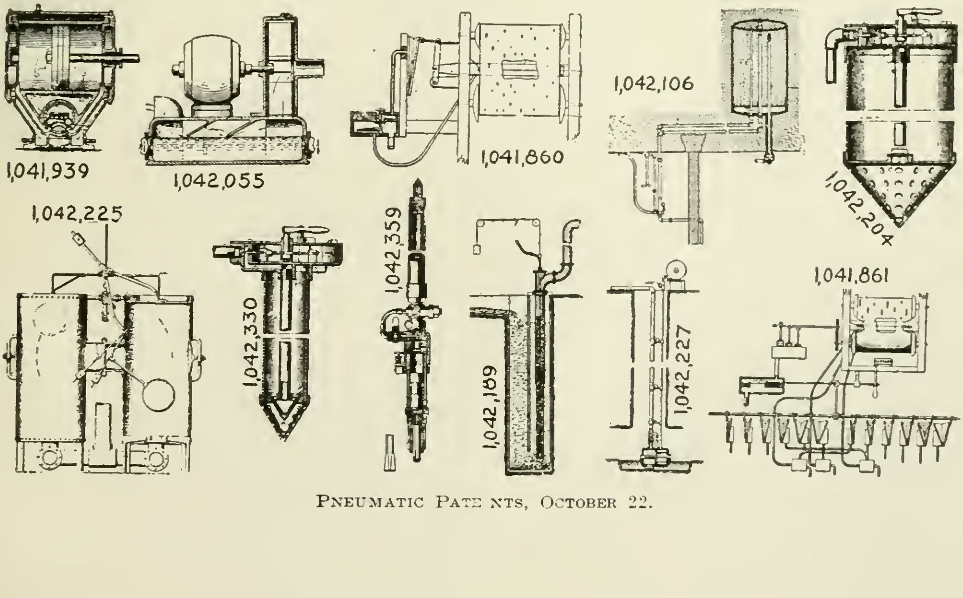
1. In a liquid storage and supply system, a storage tank, an outlet pipe leading from the storage tank, an air pressure pipe leading into said tank from a source of air under pressure, and a single valve having ports which control both the outlet pipe and the air pressure pipe; said valve also having a port arranged to connect the outlet pipe with the atmosphere, and thereby admit air to the outlet pipe adjacent to the discharge side of the valve when the valve is closed, substantially as described.

1,042,189. APPLIANCE FOR RAISING SOLID BODIES. Franz Beduwe, Liege, Belgium.

1. In an apparatus of the character described, the combination with a pit or receptacle for water and granular or fragmentary solid material, of an elevator comprising a sectional tube that extends into the receptacle, the lower intake section of said tube being telescopically connected with the section above it, a conduit extending into and connected with the intake section of the tube for supplying air under pressure to said intake section, and a counterbalance connected with said conduit.

1,042,204. WELL-PUMPING APPARATUS. John W. Darley, Jr., Baltimore, Md.

1,042,225-6. PUMPING APPARATUS. Hascal A. Hogel, Boston, Mass.



Pneumatic Patents, October 22.

1,042,227. COMPRESSED-AIR WATER-ELEVATOR. Hascal A. Hogel, Boston, Mass.

1. In a compressed air water elevator, the combination of an air pipe; a casing provided with a plurality of chambers connected to said pipe; means by which air under pressure may be admitted to one of said chambers and allowed to leak into the other; a water delivery pipe; and a connection between said air pipe and water delivery pipe above said chamber, substantially as described.

1,042,330. WELL-PUMPING APPARATUS. John W. Darley, Jr., Baltimore, Md.

1. A well pumping apparatus comprising an outer tube, adapted to admit liquid at its lower end, a cap normally closing the upper end of said tube and provided with liquid delivery and air exhaust ports, respectively, and also with an inlet passage for compressed air, an inner tube projecting downward into said outer tube and connected at its upper end to said air passage in said cap, valves normally closing said air passage and said liquid delivery and air exhaust ports, respectively, and a hand operated cam arrangement controlling said valves, substantially as described.

inder at a point above the piston, and means for controllably introducing compressed air and other gases into the cylinder through the piston rod.

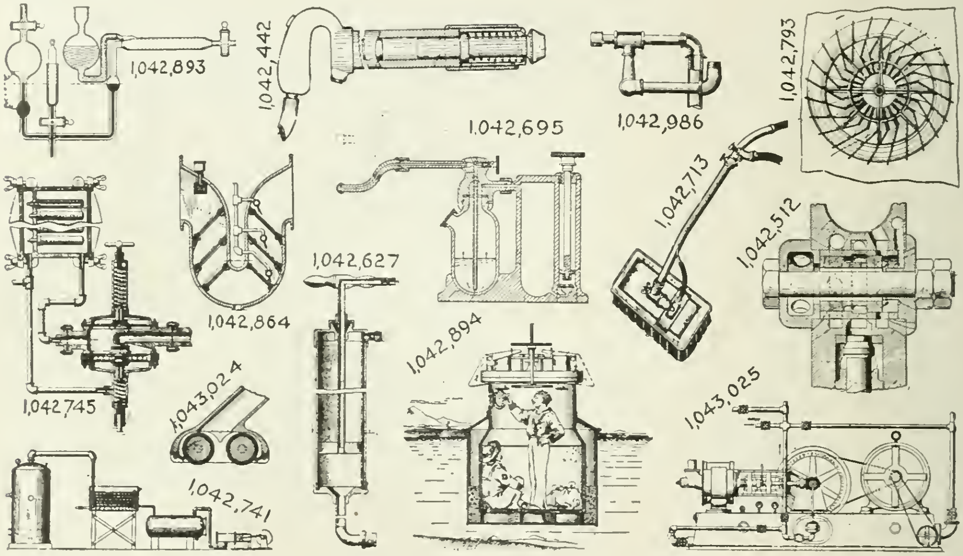
1,042,685. ATOMIZER. George J. Kelley, Attleboro, Mass.

2. In an atomizer, the combination of a casing, an air pump in the casing, a compressed air reservoir in the casing adjacent the pump, a liquid receptacle in th casing adjacent the reservoir, said casing being provided with air connections between the pump and reservoir and between the reservoir and the receptacle, a liquid tube in the casing extending into the receptacle, a bore in the casing above the tube, an air channel leading from the tube to the bore and a valve in the bore extending into the air channel.

1,042,711. VACUUM CLEANING DEVICE. Albert E. Moorhead, Chicago, Ill.

1,042,713. PNEUMATIC SCRUBBING APPLIANCE. Albert E. Moorhead, San Francisco, Cal.

1,042,745. PRESSURE-REGULATOR. Edward Zahm, Buffalo, N. Y.



Pneumatic Patents, October 29.

1,042,359. ROCK-DRILL. Edwin M. Mackie, Chicago, Ill., and Percival F. Doyle, Franklin Pa.

OCTOBER 29.

1,042,403. GAS AND AIR MIXING METER. George R. Cottrell, Anglesea, N. J.

1,042,442. FLUID-PRESSURE-ACTUATED HAMMER. Nicklaus W. Iseli, Milo, Ohio.

1,042,471. PROCESS OF RENOVATING BUTTER. Johan D. Oudsteyn, Chicago, Ill.

1. The process of renovating rancid butter or oil consisting in passing a blast of steam through the melted butter or oil while confined in a chamber free from air and from which the steam is being exhausted continuously while the blast is in operation.

1,042,512. MOTIVE-FLUID-OPERATED TOOL. Daniel Shaw Waugh, Denver, Colo.

1,042,627. GREASE-GUN. William U. Watson, Chicago, Ill.

3. In a grease gun, in combination, a cylinder, a piston therein, a hollow piston rod projecting through the end of the cylinder and having a port communicating with the inside of the cyl-

1,042,795. APPARATUS ARRANGED ON LOCOMOTIVES AND OTHER POWER-PROPELLED VEHICLES FOR UTILIZING THE RESISTANCE OF THE AIR. Julius Jaensch, Breslau, Germany.

1,042,864. APPARATUS FOR TREATING AIR. Walter Hamilton Winks, Baltimore, Md.

1,042,893. HUMIDOSTAT-REGULATOR. William M. Clark, Washington, D. C.

1,042,894. LIFE-PRESERVER. Abner D. Crull and Leonard Spangler, Indianapolis, Ind.

1,042,956. GLASS-DRAWING APPARATUS. Travis Oakes and Daniel Resslar, Mount Vernon, Ohio.

1,042,980. PRESSURE-REGULATOR. Harvey E. Shawver, Lewiston, Ill.

1,043,024. PNEUMATIC CLEANSING IMPLEMENT FOR REMOVING DUST. Albert E. Moorhead, San Francisco, Cal.

1,043,025. PNEUMATIC CLEANSING APPARATUS. Albert E. Moorhead, Chicago, Ill.

1,043,040. PULSATOR FOR MILKING-MACHINES. Anders Lassen Berthelsen, Brædstrup, Denmark.

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